



## SALTeNEWS

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**Engineers on top: the Tech Ops team during their rope safety training exercise on SALT, Oct 2008**

### SUMMARY

In the period since the last SALTeNEWS issue (Sep 2007!), work has continued on the two major technical challenges that have faced us, namely the poor imaging performance of the telescope and the low throughput of the Robert Stobie Spectrograph (RSS). The latter was removed from the telescope in late 2006 in order to address the various low throughput issues, which are now hopefully solved, as will be reported later in this issue. The telescope's image quality problems were diagnosed to be primarily a result of misalignments of the optics in the Spherical Aberration Corrector (SAC), which necessitated its removal for modifications in April of this year. The progress on this is also described in this issue.

With the main instrument, RSS, being out of action for nearly 3 years, the only science instrument available has been the imaging camera, SALTICAM. A number of observing programs, able to be attempted in the circumstances, were undertaken over this period. Most of these involved the high-speed photometry mode of SALTICAM. During the period leading up to the SAC removal, SALT was used for 50-75% of the nights for scientific observations, particularly during dark of Moon, with the remaining time devoted to engineering, mostly in support of the image quality diagnostics.

On-going engineering work has continued on SALT, aimed at addressing a number of issues. Some of these are relatively minor teething problems, while others have been more serious issues related to design flaws. In addition a number of incomplete (at the time of the telescope's inauguration) subsystems have been completed.

We are now looking forward to the completion of the SAC modifications and optical testing in the latter part of the year which will culminate in the optical acceptance testing on-sky prior to the re-commissioning of the telescope and the first-generation instruments. For the latter we are anticipating commissioning of RSS to begin in Jan 2010, although this is highly dependent on when the SAC repair and testing program is completed (see report later in this issue). At the May 2009 meeting of the SALT Board and Science Working Group, it was decided to proceed with RSS commissioning with the following priorities: long-slit, multi-object and Fabry-Perot spectroscopy. Our experience indicates that we expect the first of these to proceed fairly quickly and that this mode will therefore be the first one likely to transition to routine science operations. To assist in the RSS commissioning tasks, we are issuing a call for commissioning/performance verification proposals to the SALT community, which is mentioned in the next section of this issue.



**Removal of the SAC for its modifications and testing on 18 April 2009.**

### **CALL FOR RSS COMMISSIONING PROPOSALS**

With the expectation of re-installing RSS on SALT in Jan 2010, we are proceeding with plans for the subsequent initial commissioning phase, expected to take several months. The initial modes to be commissioned, in order of priority, are: long-slit, multi-object and Fabry-Perot spectroscopy. Polarimetric modes will only be commissioned later, following the repair of the beam-splitter mosaic.

While the RSS Instrument Team, in consultation with SALT Ast Ops, have put together a detailed commissioning plan with a variety of targets chosen to exercise the various instrument modes, we would like to expand the target list in order to always have the ability to have a target for any potential SALT observing window. For this reason, and also in recognition of the fact that astronomers in the consortium are champing at the bit to obtain data, we are making this current call for commissioning/performance verification proposals. Like for the previous calls for PV programs, these will be chosen by the

Commissioning Team (including the instrument Principal Investigator and SALT Scientist) mostly on the basis of the following criteria:

- Applicability for “exercising” the respective instrument modes
- Object position(s) and how well filled an observing queue will be
- Practicality

As for the previous PV phase, the accepted proposals will be done on a “best-efforts” basis, without formally “charging” partners for the observations. In return we expect the PIs of the proposals to provide rapid feedback to the Commissioning Team on their results, quantifying the relevant instrument mode performance.

Note that the previous PV programs which were accepted, but not undertaken due to various reasons (mode unavailability, instrument or telescope under performance), or not completed, will *not be carried over* into this new commissioning/PV phase. Therefore PIs will need to resubmit such proposals with the new proposal submission tool (PIPT) if they wish these programs to be considered. The new tool will allow target, instrument and observation information to be populated in the science database, which is required for scheduling and conducting the observations.

The call for these RSS commissioning/performance verification proposals opens on 15 Oct 2009 and the current deadline is 15 Jan 2010. Targets should be chosen under the assumption that the observations will occur in the Feb-April period.

To create and submit proposals, version 1.0 of the PIPT is needed, which will be available at <http://www.salt.ac.za/wm> from the 15th October 2009. The RSS Simulator and the Visibility Tool will also be available at <http://www.salt.ac.za/proposing/observation-planning-tools/> as before. These applications require that Java 1.5 or higher is installed on your computer. An account on the Web Manager is necessary in order to submit proposals. If you haven't got one already, you may register at <https://www.salt.ac.za/wm/Register/>

After proposal submission, you will need to use the Web Manager (<http://www.salt.ac.za/wm/>) to check your proposal and approve it. As always, your feedback on any of the above will be welcome and very much appreciated. Of course, help is only an email away. If you have any questions or encounter any problems, please feel free to contact [salthelp@salt.ac.za](mailto:salthelp@salt.ac.za) with your issue!

## ENGINEERING ACTIVITIES

The SALT Technical Operations division has been busy and making steady progress in solving a number of outstanding engineering problems with the SALT, particularly in regard to the dome and building. Some of these have been traced to design weaknesses in certain areas, or in some case poor workmanship or choice of components. Most of these tasks did not impact significantly on scientific operations, which were suspended in early April in order to effect the modifications to the Spherical Aberration Corrector (SAC) as part of the Image Quality (IQ) improvement project (reported on later).

Despite the pressures of these various engineering tasks, compounded by the loss of personnel, some good progress has been made on these issues. Even during “normal” operations, there had been a gratifying decrease in faults, decreasing to at or below the 3% loss allowed for in our system specification. Notwithstanding the number of remaining completion tasks underway, we are confident of achieving normal operations once the SAC and First Light instruments are reinstalled, beginning later this year.

Dome and building leaks have continued to plague us from day one, which have necessitated re-sealing of the dome panels. Extensive waterproofing of the telescope building was undertaken in October and November 2008. Various dome-relating problems have been addressed, including modifications to the dome shutter track and bogies and installing a rolling element on the dome arrestor hooks (which helps hold it down in high winds). Leaks around the dome skirt led to corrosion inside the dome rail, which had to be addressed, in addition to some loose bolts. The dome fixes have been completed, including the sealing of the dome nodes, skirt and the dome shutter. The CCAS tower, used to align the primary mirror, was also sealed and re-painted, together with the roof over the visitor's entrance. Further work is still

required to seal the wind louvers, which leak when there is a combination of wind and rain, not infrequent during the winter months! Design modifications have been initiated and it is expected to implement these changes once the more pressing engineering tasks are out of the way.



**Re-sealing and painting work in progress on the dome.**

Several problems with the Environmental Control System were encountered towards the end of science operations in April. One incident was due to erratic electricity fluctuations from the supplier, which damaged the glycol chiller controller, used to remove heat from many of the telescope subsystems. Other problems were related to leaks in the glycol cooling system, one case in the cooling jacket of a motor and the other a leak in the glycol storage tank due to a poor concrete finish, necessitating a repair by specialist contractor. Over the past few years, various components of the glycol cooling circuits have failed, some as a result of poor valve choice and/or corrosion in some of the glycol piping. These have gradually been addressed, but there are still remaining tasks to improve the performance of the “igloos” – the cooled electronics cabinets – most relating to better ducting of the airflow. Following several lightening incidents, which caused damage to the met mast instrumentation, a review of the electrical earthing strategy is taking place throughout SALT.

Many SALT subsystems, including the instruments, rely on pneumatic mechanisms. In addition a clean dry air purge is maintained in several crucial places where condensation or high humidity cannot be tolerated (e.g. dewar windows, optics, etc.). Initial issues relating to compressor capacity and reliability were addressed, together with piping, resulting in a more reliable system. A serious problem with water intrusion through rubber piping of instrument air, resulting in a higher than specified dew point and probable condensation episodes, is currently having to be addressed.

Over the ~4 years of operations, small cracks developed in the smooth upper layer of the concrete pier, which over time evolved into “bald spots”, causing undue wear and tear on the rubber air bearings. “Cosmetic surgery” was therefore undertaken on the pier by the original contractor, returning it to its smooth state.



**Delamination of the pier surface, which has now been repaired.**

The Primary Mirror subsystem has generally been very reliable, notwithstanding the fact that the capacitive edge sensors (SAMS) failed to perform to specification and were subsequently declared a failure. The eventual replacement of these sensors is a new project, which is reported on later in this issue. The mirror actuation system has had some software modifications, mostly to handle better error handling and expedite fault-finding. The Shack-Hartmann alignment system (CCAS), situated on top of the alignment tower, has had a number of minor, but irritating issues relating to software reliability and usability, which are gradually being addressed. In addition, software modifications are underway to improve spot centroiding in order to damp the effects of wind-induced seeing and tower shake. Small shifts of the lenslet arrays have been traced to their drive motors, which will be replaced in the near future. The majority of alignment problems have been traced to loose mirror segment mounts in the truss. Future maintenance procedures will check that the mount nuts are properly tightened to avoid this. The “SPIFFY” camera, which allows an independent assessment of mirror alignment quality, is one step closer to being installed in the CCAS tower. A new translation stage has been procured and tested and supporting hardware designed and ordered. The next phase will be its installation, together with the CCAS, on the new stage.

The CO<sub>2</sub> mirror cleaning system has been optimized and improved, resulting in routine (~weekly) cleaning of the primary mirror array. The results have been very encouraging and are clearly keeping the most recently coated mirrors in good condition. In parallel to this, the mirror segments have been undergoing recoating on a regular basis and only 5 remain to be done, which we expect to complete in the next month or so.



**Well dressed SALT Mechanical Engineer, Ockert Strydom, inspects the CO<sub>2</sub> mirror cleaning system nozzle during commissioning tests in 2008.**

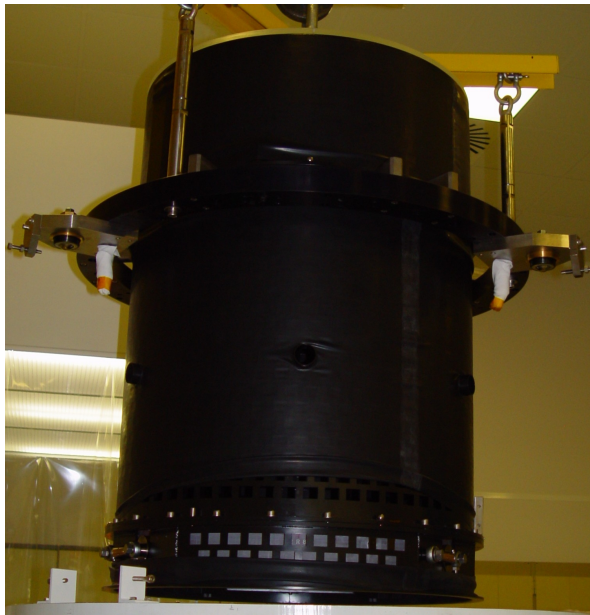
While the Tracker has performed well, a few issues have had to be addressed. One, still in progress, is improving the glycol cooling distribution to the Tracker and Payload, with one aim to ease the removal of the hexapod gearboxes for their regular servicing. The latter has been necessitated on a more frequent basis than originally planned, which may lead to a modification to the clutch design and the material used. One major issue, still under investigation, is the mass loading of the Tracker. In particular, the Payload mass, which contain the prime focus instruments SALTICAM and RSS, was above its design specification, and the impact of this has recently been assessed. While there is apparently no immediate concerns, due to the acceptable safety margins, for the new near-IR extension of RSS, there will need to be modifications to avoid overloading two of the hexapod legs. This will most likely be achieved using weight-relief measures, similar to the approach with the Tracker y-drive “anti-gravity” device, which relieves the majority of the mass of the Payload.

Ever since science observations began with SALT, we have been plagued with stray light from the Payload autocollimator, which employs a laser operating at 670 nm. An intensive investigation traced the problem mainly to a lack of appropriate baffling. In addition, neutral density filter have also been employed, resulting in an overall reduction in the scattered light close to acceptable levels. Once the SAC is reinstalled on the telescope, final measures will be implemented, including moving the autocollimator closer to the optical axis such that the illuminated spot on the primary mirror is further inside the SAC’s central obstruction. The Calibration System (flat field and arc lamps), which is deployed below the SAC, will also need to be modified to allow adequate baffling of the autocollimator light when it is retracted.

The rotating part of the Payload was removed together with the SAC at the beginning of April. This contains most of the facility instrumentation: SALTICAM (the acquisition camera), the Atmospheric Dispersion Compensator (ADC), the exit pupil baffle and mask, foci selecting fold mirrors and all of the electronics for these subsystems. Various tasks associated with these are underway during the engineering stand-down, including re-packaging and re-cabling of electronics to aid in maintenance and repair. With the Payload located at the prime focus of SALT, access is very difficult and experience indicated a need to re-visit the electronics bay layout to ease servicing. In addition to this, before the Payload is re-installed, further work is required on both the exit pupil baffle and mask before they are commissioned together with the ADC. In parallel, some preventative maintenance will occur on the fold mirror stages while the guidance systems for both RSS and SALTICAM require additional work related to their integration and testing.

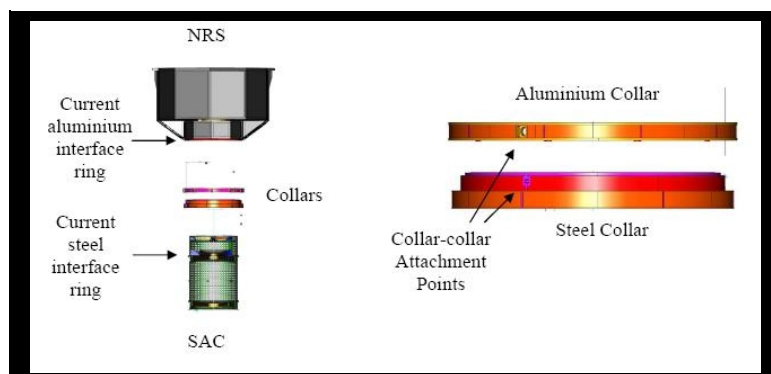
## **IMAGE QUALITY PROJECT**

SALT's image quality (IQ) problems have been widely documented and include a focus gradient across images which exhibit a position angle dependency as well as strong radial dependency of various aberrations. After a considerable diagnostic effort, led by Darragh O’Donoghue, part of the problem was traced to the manner in which the SAC is attached to the non-rotating structure (termed the NRS) of the Prime Focus Payload. The design of the attachment, consisting of a flange with 25 bolts, was too simplistic and resulted in significant variable distortions of the mounting ring, caused by both position and temperature changes. These in turn affected the precise positions of the four internally mounted and precisely aligned SAC mirrors, causing dynamic optical misalignments. The FEA model of the distortions of the SAC is shown below, next to a photo of the SAC itself.

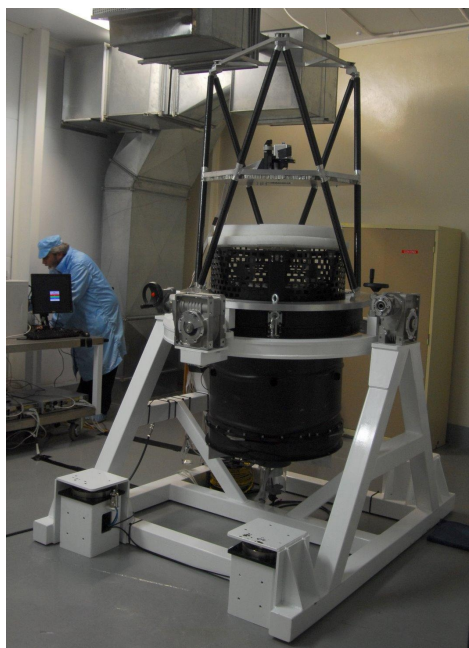


**Left: the SAC structure. Right: the FEA result showing the expected distortions.**

Following this realisation, a redesign of the SAC mounting scheme began in 2008, with the aim of installing semi-kinematic interface collars between the SAC mounting flange and the non-rotating payload structure (NRS). This interface allows for mechanical and thermal deflections without transferring them to the SAC structure or the mirror mounts. The interface collars plus a testing rig were manufactured early in 2009 and the SAC was removed from the telescope and installed with its new interface collars in the test rig in April.

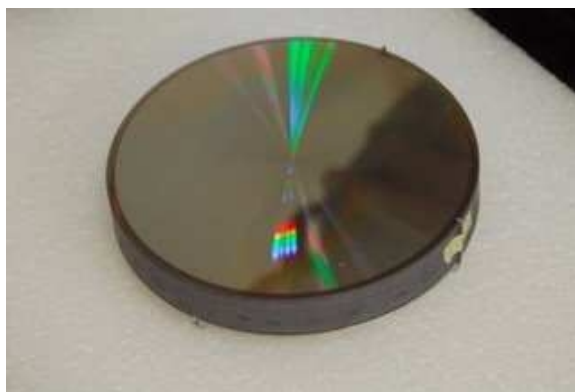


**Schematic of the redesigned SAC-NRS interface**



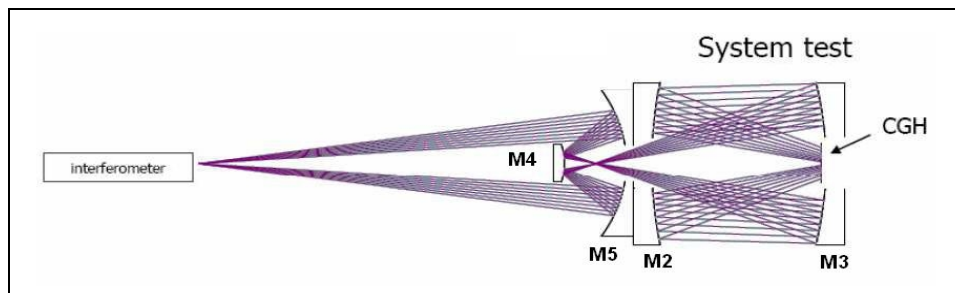
**The SAC installed with its new interface collars in the testing rig (NRS simulator) inside the mirror handling room at SALT, with Darragh O'Donoghue working in the background.**

A comprehensive SAC repair and test plan, formulated by Darragh, began in April with the removal of the SAC from the telescope. All of the subsequent work on the SAC has been conducted in the semi-clean room environment of the SALT Mirror Coating Room. The SAC repair plan calls for the installation of its new interface to the telescope, realignment, and optical testing. Testing of both individual mirrors and sub-systems of the SAC are being carried out. The entire SAC system will also be tested using a Computer Generated Holograms (CGHs), designed by the College Of Optical Sciences, University of Arizona, and fabricated in Russia.



**The first of two CGH test optics.**

In order to test the SAC at the actual operating angle of  $37 \pm 6$  degrees to the vertical, the NRS simulator test rig allows the SAC to be tip/tilted and rotated. This allows for full testing of the system as it is mounted on the telescope, which was not done originally due to the lack of a suitable system test which would work at angle. The system test employed by the SAC vendor, SAGEM, was based on a large mangin mirror, which could only operate in the vertical position. The plan is now to use much smaller CHG optics to simulate the spherical primary, which will test over the full operational range of altitude. These system tests, plus tests of some the individual mirrors, or mirror combinations, are being conducted using both a Shack-Hartmann wave-front camera and an interferometer, procured this year.



**Schematic of the full SAC system test employing the Computer Generated Hologram (CGH).**

Zemax modelling has shown that a relative misalignment of mirrors M4 or M5 by 0.5mm in decentre or 0.1-0.15 degrees in tip/tilt can lead to an angular focus gradient of about consistent with observations. Accurate metrology of the relative positions of these mirrors confirmed that interface-induced shifts of this order were indeed observed. However this may not be the entire story, since there is an additional variation in the magnitude of the focus gradient, not easily explained by the interface alone. Further diagnostic efforts are therefore underway to investigate this issue.

In order to be able to fully test the SAC and its subcomponents, various instruments have had to be procured, and experience gained in optimally using them. These include various metrology devices, including Faro arms, capable of measuring positions in 3-D to accuracies of 20µm, or even less. Crucial to the optical diagnosis is an interferometer, which was purchased earlier this year, as was an alignment telescope. With this hardware and the rapidly gaining experience of the SAC repair team, steady progress has been made in executing the repair plan. Details of progress can be obtained by viewing the photo-history on Lisa Crause's blogsite (<http://saltiqmission.blogspot.com/>), while the full details of the repair plan are posted on the partner pages of the SALT website, together with the whole history of the image quality diagnosis, at <http://www.salt.ac.za/iq/the-salt-image-quality-story/>.

The current status can be summarized as follows, from Darragh's latest report to the SALT Board Executive:

- The SAC repair plan is proceeding according to plan, albeit slowly. All steps in the plan are now fully defined and almost all have been executed on a trial basis. The M2 test is fully defined and the full-aperture CGH has been designed and is in fabrication.
- The most notable achievement to date has been showing that the figure of M5, mounted in its opto-mechanics, is good and is preserved over the range of operational angles and temperature.
- The M4/M5 test has been executed, informally, repeatedly and it seems that the figure of M4 is good.
- It is not anticipated that significant further expenditure is required unless the problems have been incompletely diagnosed and further repairs, currently unanticipated, are needed.
- Most technical risk has disappeared. Schedule risk remains and is hard to constrain.
- No evidence has been found for effects other than due to the bad interface, but this statement does not yet have a strong support base.

The progress in solving this one remaining problem with SALT, which has prevented us reaching full science capability, has truly been a team effort. The major players have been Darragh himself, ably assisted by Lisa Crause, James O'Connor and Francois Strumpf, who joined the group earlier this year from the aerospace industry as an Optical Scientist. Significant engineering effort has also come from both SALT and SAAO technical staff, particularly Ockert Strydom and Craig Sass. Our firm belief is that the all of the effort, the long hours and the frustrations encountered in trying to rectify SALT's image quality problems will soon bear fruit. Our gratitude and admiration of those who have sacrificed so much to achieve this goal cannot be overstated.



Some of the gang. L-R: Ockert Strydom, Darragh O'Donoghue, Janus Brink & Lisa Crause.

## INSTRUMENTATION UPDATES:

### **RSS (The Robert Stobie Spectrograph)**

RSS was removed from the telescope and the optics shipped to the USA in November 2006 in order to diagnose and repair the cause of the poor UV throughput performance (described in the last SALTteNEWS). The polyurethane lens fluid bladders were found to have reacted with the lens fluid material, producing a UV-absorbing polymer, despite the material having been declared as compatible. This affected the throughput of all of the multiplet lenses, in both the collimator and camera, and necessitated changing combinations of the bladder, o-ring and fluid materials to achieve the required throughput performance.

These repairs were essentially completed in September 2007, when one of the  $\text{CaF}_2$  elements being reassembled in the collimator main group was accidentally damaged, requiring its replacement. Although we had a spare blank, the fabrication and coating of this lens delayed the reassembly by ~9 months. Following the delivery of this replacement lens, the collimator triplet was reassembled and refilled with the index-matching lens coupling fluid. The immediate effect of this was to cause the central NaCl element of the triplet to fog, presumably due to some water contamination in the fluid. This disheartening news meant that the triplet had to be dis-assembled and the NaCl lens removed and re-polished. This was completed early this year and following reassembly and testing, the main RSS optics were finally received back in South Africa at the beginning of June. The one remaining item which is still under repair is the polarizing beam-splitter array (a 3 x 3 array of Wollaston prisms). On reassembly of this item, following its coupling fluid replacement, some of the prisms were damaged, which has necessitated its repair by the original vendor, currently underway.

During the ~2 years that RSS has been off the telescope, various modifications to the mechanics were made to improve reliability and ergonomics and to address various latent design defects that came to light during commissioning and performance. The biggest task was the redesign of the slit-mask exchange system, to avoid misalignment induced faults. This work has been primarily carried out by the SALT Technical Operations group, in frequent consultation with the RSS Instrument Team at the University of Wisconsin (UW) and Rutgers University (RU).

Modifications to the RSS CCD detector system were also completed during the downtime, primarily by Luis Balona and Dave Carter (SALTICAM Instrument Team). During testing in Cape Town, a fault with the heater system caused a resistor in the cryostat to burn out, resulting in mild contamination of the CCD mosaic. This necessitated returning the CCDs to the supplier, E2V in the UK, who fortunately managed to clean off the contaminating film, with no ill effects. Following this incident, fail-safe circuitry was installed to avoid a similar incident in the future. Finally, the CCD gain parameters were altered in order to optimize the full-well performance in the various gain/readout modes.

On 8 June this year, part of the team from UW, comprising Ken Nordsieck, Marsha Wolf, Mike Smith & Bill Mason, returned to SALT to reinstall and align the optics and to begin functional testing of the instrument. This was followed by a visit from Ted Williams (RU), who began a series of tests of the performance of the Fabry-Perot etalons. The latter tests revealed that two of the three etalons (low & medium resolution) had deteriorated anti-reflection coating on their outer surfaces, likely as a result of condensation during commissioning observations on the telescope. Fortunately this does not seem to have affected the resolution or finesse of the etalons, and further testing will await the re-installation on the telescope. The most likely affect will be reduced throughput and possibly more scattered light.

All of the RSS modification, reassembly and testing work, which is still continuing, was assisted by SALT Technical Operations staff, principally Peter Menzies and Eben Wiid, the SALT Astronomers Amanda Gulbis, Alexei Kniazev, Nicola Loaring and Petri Väisänen, local RSS support scientist, Steve Potter and David Buckley. While there are a number of tasks still to complete before RSS is re-installed, probably in mid-Jan 2010, we are well on track.

### **SALTICAM**

This has been the stalwart instrument on SALT since the removal of RSS in late 2006, and various scientific programs, mostly high-speed photometry of variable stars have made full use of it. Since the suspension of science operations in early April, SALTICAM has been removed from the prime focus payload to undergo some modifications, termed the “big fix”.

This will be done in two phases, with initial work concentrating on installation of a new PLC-based control system, new focus motors, various modifications, filter encoding, new software control and installation of the auto-guidance and focussing system. In the second phase, cryostat “surgery” will be required. This is to install the modified moving frame-transfer mask, which includes the slot for high-speed photometry. The modification is necessary to reduce vignetting and scattered light effects. In addition a safer heater servo system will be installed to avoid a potential short circuit, which occurred with the RSS detector.

It is anticipated that at least the first phase of the “big fix” will be completed in time for on-sky verification of the telescope’s image quality, following the reinstallation and testing of the SAC on the telescope. It is also planned to commission the SALTICAM backup camera, B-CAM, once the telescope is on-sky again. This is a simple acquisition camera utilizing an Apogee 2k x 2k CCD camera and simple custom-made focal reduction optics. It will serve as a spare acquisition camera, should SALTICAM need to be removed from the telescope in future for any reason.

When SALTICAM is finally re-commissioned, an increased choice of filters will be available, including the existing Johnson-Cousins UBVRI set, plus a set of Sloan filters (u', g', r', i' & z'), Strömgren filters (u,v,b,y, H $\beta$  wide & H $\beta$  narrow), an H $\alpha$  filter and several custom made interference filters (at 340, 380, 610, 705, 815 & 860 nm).

### **RSS NEAR IR ARM**

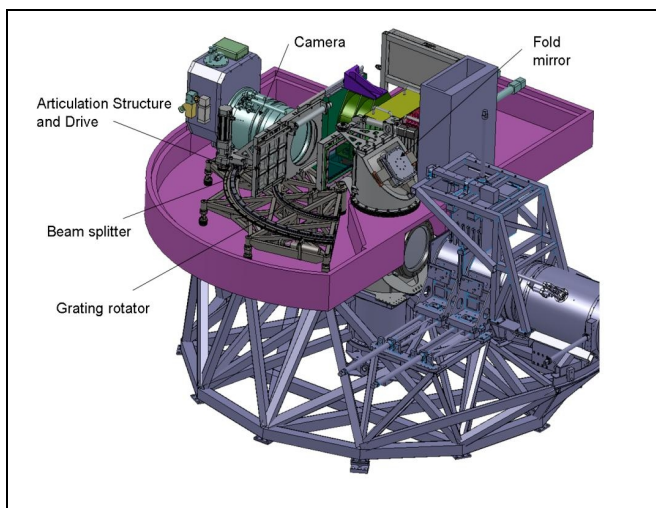
Good progress has been made on the design development of the near-IR extension to RSS, which will increase the wavelength range to  $\sim 1.7\mu\text{m}$ . Two successful design reviews have been held, in July 2008 and May 2009, and the design has now matured to the extent that the first contract has been let for the major long-lead item, the Hawaii-2RG infrared array, from Teledyne Corp. At the Nov 2008 SALT meetings at IUCAA, in Pune, India, the Principal Investigator, Andy Sheinis (UW), informed those present of the excellent news that he’d secured a total of US\$5.3M in funding, a significant fraction of the currently estimated \$6.1M cost (excluding contingency). Following the Mid-Term Review and SALT meetings in May this year, discussions are underway regarding the remaining funding requirements and how the secured funding will be recompensed.

There have been a significant number of technical challenges in the design, namely:

- Provision of cooling to allow reduce the thermal background to below the sky at the upper wavelength limit of  $\sim 1.7\mu\text{m}$ .
- Providing sufficient spectral resolution and coverage and flexibility to ensure competitiveness
- Constraining the mass and volume of the instrument

The resulting design has immensely benefited from a rigorous review process, which has involved a number of leading experts: Hans Dekker (ESO), Darren DePoy (Texas A&M), Gary Hill (U. Texas/HET), Ian McLean (UCLA) and Keith Taylor (formerly Caltech).

The next issue of SALTeNEWS will highlight the RSS-NIR developments, including the expected performance and the science drivers. Details can be seen at the project website (go to [www.sal.wisc.edu/PFIS/](http://www.sal.wisc.edu/PFIS/) and proceed to the RSS/NIR pages), and particular the project “Red Book”, produced for the last review ([www.ssec.wisc.edu/nir/mtr09/mid\\_term\\_review.pdf](http://www.ssec.wisc.edu/nir/mtr09/mid_term_review.pdf)).

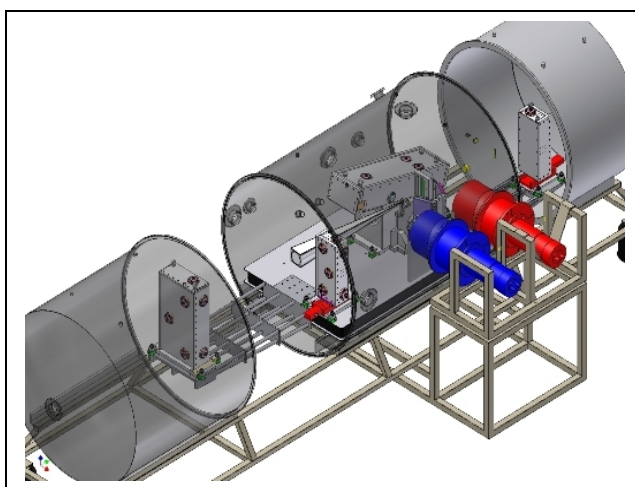


**Current design of the RSS-NIR arm, without its cooled “pre-dewar” enclosure. The UV-VIS beam of RSS is seen to the lower right.**

### SALT HRS

Good progress continues with the construction of the High Resolution Spectrograph at the University of Durham. Contracts have now been let for the two CCD detector packages, the échelle grating mosaic, the camera optics and the mirrors, with others expected soon for the vacuum enclosure, the dichroic and the fibre optics. Final mechanical design work and the optical slicing design will soon be completed.

An additional operational mode has been added to the functionality, namely high precision radial velocimetry. This will use either an iodine absorption cell, a fibre double scrambler or simultaneous ThAr arc injection, or combinations of these. Together with the temperature stabilization of the vacuum enclosure, this should allow for radial velocity accuracies of several m/s, ideal for the detection and monitoring of exoplanets.

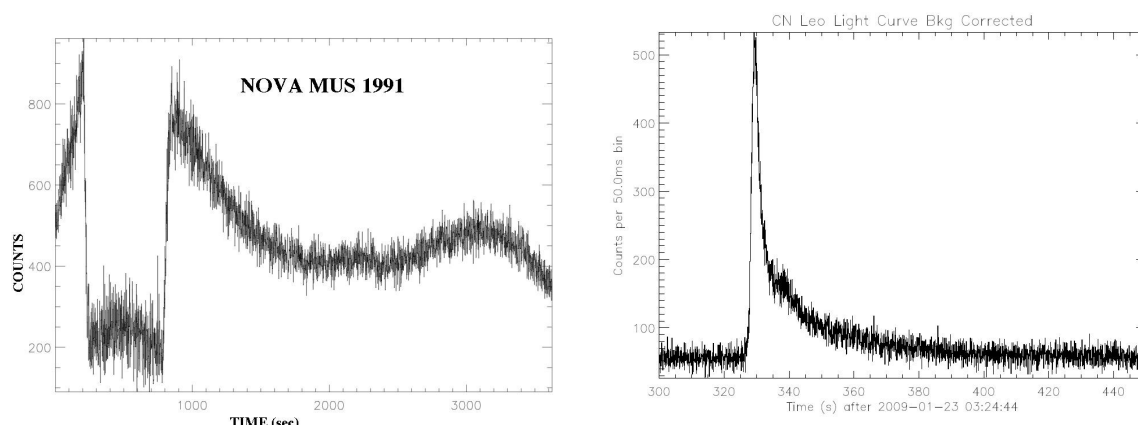


**Model of the HRS with the vacuum enclosure sections separated. The “blue” and “red” cameras are so coloured.**

The current schedule has HRS completing its assembly and testing phase at Durham at the end of 2010, whereupon it will be shipped to SALT and begin a several months of commissioning in early 2011. Details of the HRS project can be seen on the project website: [www.cfai.ac.uk/salt/HRS/index.html](http://www.cfai.ac.uk/salt/HRS/index.html)

## BVIT

A prototype visitor instrument, the Berkeley Image Tube Camera (BVIT), was successfully commissioned at the SALT Auxiliary Focus from 20 – 26 January. This is a high-speed photon counting camera, featuring a Micro Channel Plate (MCP) intensifier and strip anode readout, with a 2 arcmin diameter field of view. The current configuration features an S20 photocathode with a relatively low peak QE (10%) and narrow sensitivity curve, but is capable of precise time tagging of photon arrival times to at least 1  $\mu$ s.



**Examples of lightcurves obtained during the BVIT commissioning run in Jan 2009. Left is an eclipse observation of the X-ray transient, Nova Muscae 1991, and right is a flare observed on CN Leo. Each data point was binned to 1 sec resolution.**

The installation of BVIT was completed in an afternoon by the BVIT team consisting of Ossy Siegmund, Jason McPhate and Doug Rogers from UC Berkely Space Science Lab, with help from SALT Technical Ops, particularly Ockert Strydom and Charl du Plessis, and the first commissioning and science observations were obtained on the very same night. Observations of rapidly varying objects (e.g. CVs, LMXBs, X-ray transients, flare stars) were obtained during the week long commissioning run, supported by Amanda Gulbis. These initial results showed the future promise of this instrument for high time resolution astronomy, one of SALT's niches. While the current performance in terms of sensitivity is less than SALTICAM – a CCD based camera – it is planned to upgrade the BVIT photomultiplier to a SuperGen II device in the near future. This will boost the total count rate by at least a factor of 10X, by increasing both the peak sensitivity and wavelength response.

*David Buckley (dibnob@sao.ac.za)*

## SALT PIPELINE

In the past six months, a new version of the SALT reduction software, PySALT, has been released and major upgrades have been introduced to the SALT pipeline and data delivery. On 6 March 2009, PySALT v0.33 was released to the SALT community. This release included updates to the basic reduction software, improvements in the slotmode photometry, and a fix for a bug in the slotmode timing software.

A post-observation software fix, slotutcfix, was implemented to fix several problems involving the UTC timing of slotmode observations. The main problem was related to the computer recording the data losing time. Since SALTICAM does read out the data at a constant rate, this could be fixed in post-processing software. More information about the problem and the fix can be found on <http://www.salt.ac.za/> under 'Known Issues' in the Science section.

Major upgrades to the pipeline software and the bandwidth at SAAO have significantly improved the data delivery. Now, users can select to be notified and download their raw data as soon as it has reached Cape

Town. This has already been used by some observers to provide immediate feedback to the SALT astronomers to improve and refine their observations.

Work still continues on the PySALT package and the SALT pipeline including: Development of the reduction package for SALT longslit and multi-object observations, improvements and greater functionality for the slotmode analysis tools, increase quality control in pipeline reductions., and users will soon be able to download their data via the web manager.

For those interested in contributing to the SALT data reduction software, please contact Steve Crawford ([crawford@sao.ac.za](mailto:crawford@sao.ac.za)) for more information.

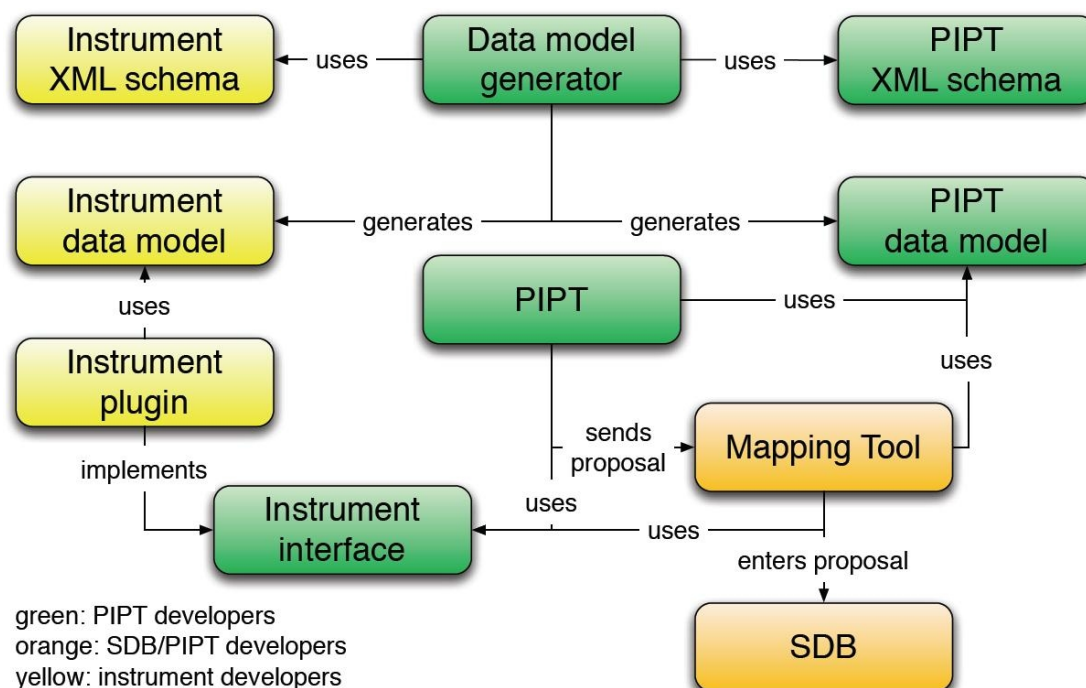
*Steve Crawford, SALT Data Manager ([crawford@sao.ac.za](mailto:crawford@sao.ac.za))*

## SALT PROPOSAL TOOLS

### ***Coming Soon to a computer near you: new versions for the Web Manager and PIPT***

When it comes to publishing new versions of the PIPT, it has been rather quiet over the last few months. The reason is that much effort has been put into changing code deep under the hood. In particular the data model used for representing a proposal as Java objects has changed substantially, with several improvements for future developments. Most notably, the next PIPT version will allow instrument plugins. In other words, new instruments can be added without having to change any of the existing PIPT code. All the required functionality for a new instrument can be provided in separate jar file. Even better, as long as the developers provide a schema for describing the instrument, they can create the required Java classes automatically from a simple configuration file. And as the PIPT provides various general GUI classes for handling proposal information, creating an instrument plugin can be a rather straightforward task.

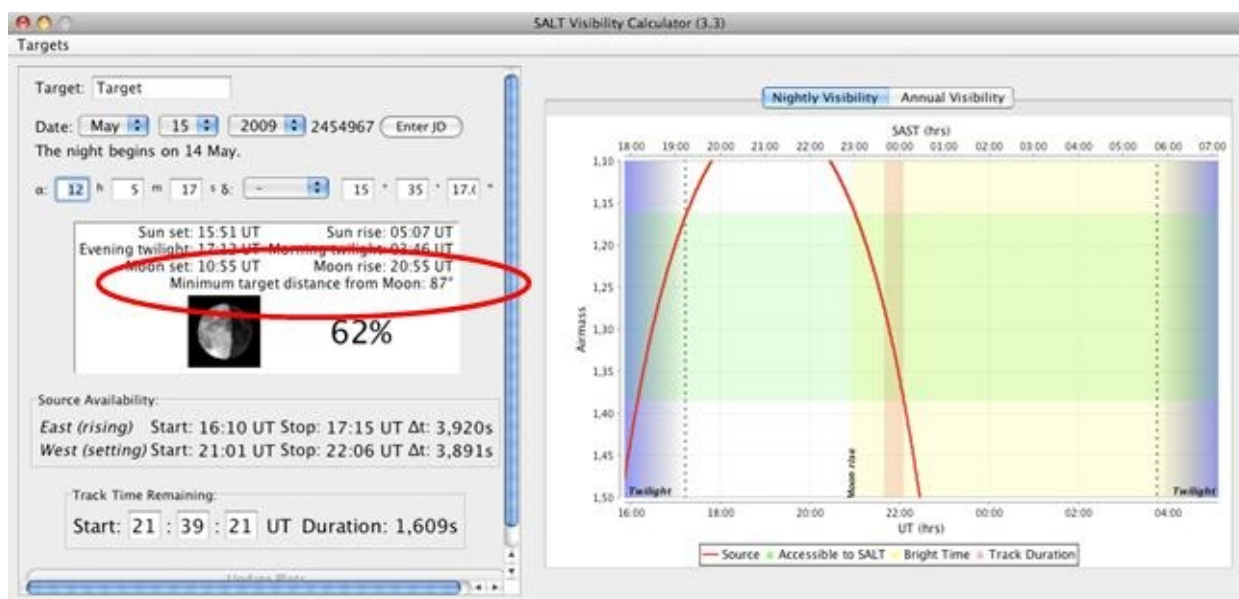
The figure below illustrates the general layout of the PIPT and where the various developers have to contribute.



On a similar footing, the new data model is more transparent than the previous one. In particular, checks going beyond those allowed by a schema can be added in a more logical manner. This opens the door to addressing to an important feature lacking so far: The PIPT must be able to perform certain plausibility checks, such as whether a target is visible and whether a user-defined configuration actually makes sense.

Another feature which will be implemented in the next version affects the Visibility Tool: The lunar

information displayed for the given date will be augmented by the minimum angular distance between target and Moon during the night. A preview is shown below. Needless to say, the same functionality will be provided for the SALTICAM and RSS Simulator as well. (And yes, the angular distance between the target and the Sun would be useful and will be added as well.)



Apart from the work mentioned so far, there naturally have been the odd bits and pieces of bug fixing. Among these is a major improvement of the memory usage for both the SALTICAM and the RSS Simulator. Out-of-memory errors, which rendered these tools non-responsive, should be a matter of the past now.

Development for the Web Manager (WM) is continuing as well; here, the next milestone will be to allow PIs to access their observed data. This will be extremely simple: The PI first searches the Science Database for the desired observations, she then decides what should be included in the download (raw data, reduced data, calibrations etc.), and finally she requests the data. As soon as the data files are available, she receives an email notification with the instructions how to download them. The images below illustrate what all this will look like.

SALT - Web Manager - Test - Konqueror

File Edit View Go Bookmarks Settings Window Help

http://localhost/wm/index.php?tab=DownloadData&Query=FileData.FileData\_Id < 500

<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	30.045	1	Show files	S200812300272.fits	2008-12-30 20:52:46
<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	20.043	2	Show files	S200812300274.fits	2008-12-30 20:59:05
<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	20.045	1	Show files	S200812300268.fits	2008-12-30 20:45:34

### ③ Set options

Include in download:

- ☐ Raw
- ☐ Reduced
- ☐ Data products
- ☐ Calibration
- ☐ Frames
- ☐ Documentation

### ④ Download

download request.

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SALT - Web Manager - Test - Konqueror

File Edit View Go Bookmarks Settings Window Help

http://localhost/wm/index.php?tab=DownloadData&Query=FileData.FileData\_Id < 500

<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	30.045	1	Show files	S200812300272.fits	2008-12-30 20:52:46
<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	20.043	2	Show files	S200812300274.fits	2008-12-30 20:59:05
<input type="checkbox"/>	2008-1-RSA_OTH-001	ESO197-10	01:53:13.00	-49:33:40.00	20.045	1	Show files	S200812300268.fits	2008-12-30 20:45:34

### ③ Set options

Include in download:

- ☐ Raw
- ☒ Reduced
- ☐ Data products
- ☐ Calibration
- ☐ Frames
- ☒ Documentation

**Web Manager**

Successfully requested files for download. You will receive an email as soon as the data is available.

OK

### ④ Download

download request.

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Christian Hettlage, SALT Java Developer (hettlage@sao.ac.za)

## STAFF MOVEMENTS

Early this year we were very sad to see Herman Kriel, combined SALT Tech Ops Manager & Systems Engineer, depart for pastures new, namely to our sister telescope, the HET in Texas. His Tech Ops Management position was recently filled by Chris Coetzee, who joined in July from the aerospace sector.

This year we've been fortunate to secure the services of Peter Gillingham for two ~3 month spells, which comes to an end this month. Peter is a mechanical engineer, who was for many years the operations engineer at the Anglo-Australian Telescope, before he left for Keck to assist in commissioning. He eventually returned to Australia, to the Anglo-Australian Observatory, in Sydney, before retiring. Since then he has continued to work actively a consultant on many telescope and instrument projects, at the AAO and elsewhere. During his tenure at SALT he has fulfilled a role as "engineer without portfolio", contributing to a number of projects, primarily the SAMS (SALT edge sensors).

On the SALT Astronomers front, Amanda Gulbis joined us from MIT in July 2008, replacing Martin Still, who had moved onto to MSSL. His position managing the Python-based data reduction pipeline development was subsequently taken over by Steve Crawford. Yas Hashimoto, who completed his contract earlier this year, has taken up a post in Taiwan. His SALT position is about to be filled by Tim Pickering, formerly from the MMT Observatory in Tucson, who joins us later this month.

Tim-Oliver Husser, who spent over a year in total tirelessly working as a PHP developer for our "Webmanager" program, finally returned to Göttingen earlier this year where he is continuing his PhD studies.

Our local Frenchman, Sebastien Buous, also finally returned home in May, having contributed hugely over the last couple of years on the SAMS project (to be reported on in the next issue).

Finally, Pim Schellart, a graduate student from Nijmegen in the Netherlands, has recently joined us for a ~6 month stint, assisting in the data pipeline developments.

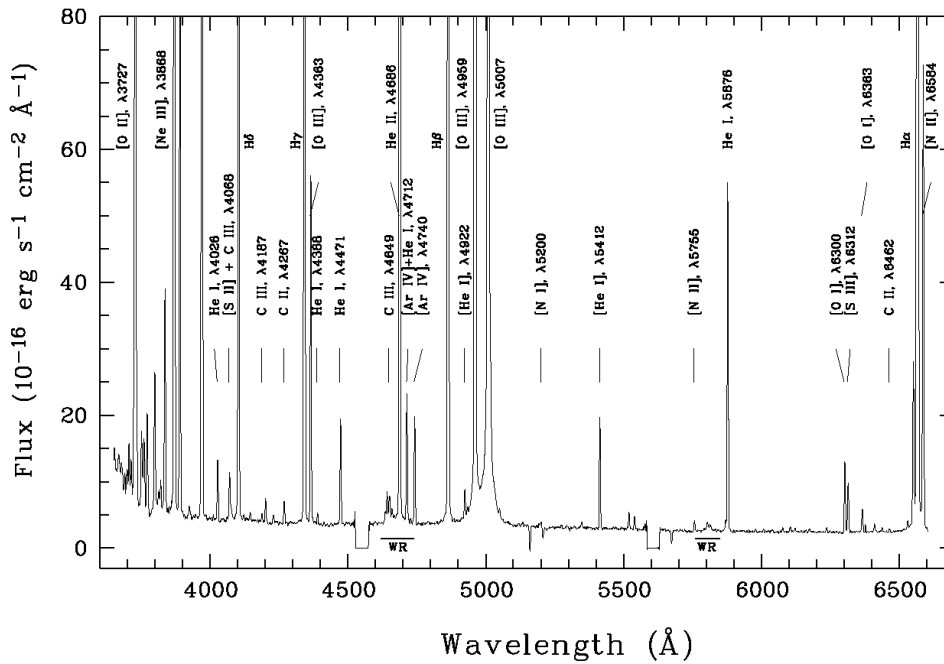
## SALT SCIENCE

The following summaries report on recent science publications featuring SALT data.

### ***Probing chemical evolution of the nearby galaxies with HII regions and PNe*** ***[Kniazev et al. 2008, MNRAS, 388, 1667]***

Understanding how the elemental abundances of galaxies have changed over time is an essential issue for understanding galaxy evolution. Abundance measurements constrain theoretical models, providing important clues on modes and rates of star formation in galaxies and on the importance of infall and outflows. HII regions indicate the present-day gas-phase element abundances, while planetary nebulae (PNe) reveal the chemical composition of a galaxy at "intermediate" ages of a few 100 Myr to a few Gyr. Spatial information of the evolution can be also traced with any observed abundance gradients. The modern level of astronomical instrumentation and new large telescopes like SALT allow us to make new a step in understanding the chemical evolution of nearby galaxies.

RSS long-slit spectroscopy was used by Alexei Kniazev (SAAO) and others to study two planetary nebulae with extreme metallicities in the Sagittarius dwarf that is the closest known dwarf spheroidal galaxy and strongly disrupted by its interaction with the Milky Way. They confirm that one of studied PN (StWr 2-21) is the most metal-rich PN known in any dwarf spheroidal galaxies. This result supports idea that the Sagittarius dwarf contains a younger stellar population, in good agreement with spectroscopic abundance measurements in Sgr stars. According to their analysis, another studied PN (BoBn 1) has an abundance of 1/76 of the solar value at the time of its formation and it is the most metal-poor PNe with well-determined abundances known up to date.



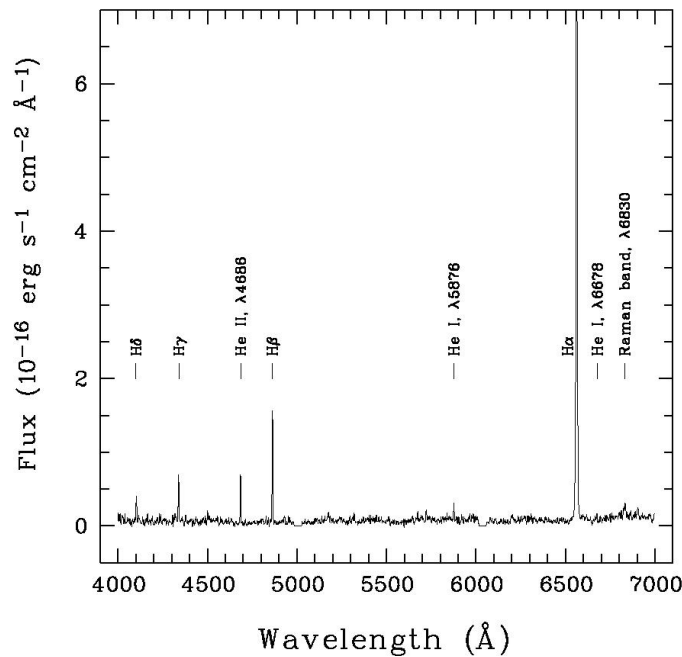
One-dimensional reduced spectrum of the planetary nebula StWr 2-21. Most of the detected stronger emission lines are marked. Altogether ~50 emission lines were detected in the observed spectrum and were used in the analysis.

***Discovery of the first symbiotic star in NGC 6822***  
***[Kniazev et al. 2009, MNRAS, 395,1121]***

Alexei Kniazev and others report the discovery of the first symbiotic star in the Local Group dwarf irregular galaxy NGC6822 that was identified during a spectral survey of emission-line objects with RSS on SALT. The symbiotic star is a binary star contains a red giant and a small hot star, such as a white dwarf, surrounded by nebulosity. The symbiotic phase represents a late stage in stellar evolution and a brief span in the life of the binary. Because of the short timescale involved, symbiotic stars are rare objects. Less than 200 are known in the Milky Way. The newly found symbiotic star is located at a distance of ~2000000 light years from the Earth and is 1800000 times fainter than could be detected by the human eye.



**Artist's conception of a symbiotic star system.**



**The observed RSS spectrum of the newly discovered symbiotic star in NGC6822, showing the various identified emission lines.**

## THE BACK PAGE

Having heard all the latest updates regarding SALT, you may ask what SALT team members get up to in their spare time. It seems that the running bug has bitten several of us SALTIES and over the past year we have had enormous fun (and agony!) taking part in local and international races.

Petri Vaisanen, otherwise known as “Yoda, Jedi Master” successfully completed the Two Oceans ultra-marathon on Saturday 11<sup>th</sup> April 2009. No mean feat, it involved 56 km of running, taking him from Newlands in Cape Town, out along the Cape Peninsula and back again. The route is famous for the beautiful stretch along Champmans Peak Drive, the stunning coastal road used for car advertisements. The only down side is that it is distinctly uphill! Petri managed to finish in only five hours and forty two minutes. Simon Fishley and Hamish Whittal from our IT department and Christian Hettlage also completed the half-marathon race on the same day.

Unfortunately, I was unable to attend the Two Oceans ultra- and half-marathons because I was in Paris, running my first marathon! I could not manage the blistering Jedi pace, finishing 42.2 km in just over ten minutes faster than Petri's ultra time, however I was relieved to be able to walk away from the experience in one piece!

We are not about resting on our laurels at SALT however! This past Sunday “Team SALT” completed our 2009/2010 season opener in the form of the Cape Town Gun Run. Petri, Christian, Steve Crawford and I had a fabulous early morning run along Green Point and the V&A waterfront and are now gearing ourselves up for a summer of running (with some work interspersed of course!)

*Nicola Loaring, SALT Astronomer, nsl@sao.ac.za*