F INSTRUMENTATION DIVISION

Head of Division: D O'Donoghue

F1 OVERVIEW

The traditional activities of this Division include:

- Developing new instrumentation and maintaining and upgrading existing instrumentation on the SAAO telescopes.
- Providing support to Telescope Operations to maintain and upgrade the SAAO telescopes.
- Supporting facilities operated for institutions from abroad.
- Student training.

As is evident below, there is ample evidence of hard work and solid achievements in all these areas during the period being reported on.

However, a major new initiative has been involvement in developing optical designs and instrumentation for SALT. This was initiated in the preceeding year but the pace has increased to the point where it is now consuming more than 50 per cent of the effort of the Division. This is the first time that SAAO has developed instrumentation:

- for an external party (the SALT Foundation);
- under legal contract – to a tight schedule;
- to a strictly limited budget;
- to quality standards expected of instrumentation for a 10-m class telescope, involving project management techniques and externally attended design reviews.

In particular, SAAO has a contract for the construction of SALTICAM, the commissioning instrument, acquisition camera and science imager for SALT. It has also undertaken to provide the detector package for the Prime Focus Imaging Spectrograph. The cost of both these projects is about $0.5M each, and will be met by the SALT Foundation. Both projects have passed their Preliminary Design Reviews and are progressing well.

F2 INSTRUMENTATION DEVELOPMENT

F2(a) SA–Japan InSb Camera

Instrument Scientist: I Glass

Work continued on the new 512 × 512 InSb camera being produced as a collaboration between I Glass (SAAO), K Sekiguchi (NAOJ) and Y Nakada (Tokyo). Work at SAAO focused on software development during the period under review. Mechanical work included a modification to the way in which the refrigerator was attached to the camera system in order to isolate vibrations. A special stainless-steel bellows was purchased to replace the previous solid mount and a rubber-isolated mounting platform was constructed beneath the camera.

F2(b) Infrared Photometers

Instrument Scientist: I Glass

The Mk II photometer electronics was re-designed by P Fourie (SAAO) and is currently undergoing shakedown testing.

The Leybold pump outfit usually used with the Mk II developed a vacuum leak and has since been overhauled. In the meantime, the Alcatel pump outfit has been in use.

F2(c) SAAO Two-Channel Polarimeter

Instrument Scientist: S Potter

Design work for this instrument was completed during the period under review. Production drawings have been generated by J O'Connor and production will be scheduled once SALTICAM production work is concluded. More details are given in the Mechanical and Electronic Sub-Division reports.

F3 SALT-RELATED WORK

F3(a) Optical Design

The SALT Atmospheric Dispersion Corrector concept was developed in 2000. A presentation to the SALT Science Working Group (SWG) was made in April 2001, and the concept was accepted. Further design work, in collaboration with A Swat (SALT), was carried out and a specification was completed by the end of 2001.

D O'Donoghue also developed a slit viewing system based on an Offner relay concept. The system is intended to relay images of the prime focus imaging spectrograph's long slit to SALTICAM to assist with positioning stars in the slit.

F3(b) SALTICAM

The go-ahead to construct SALTICAM was given by the SALT SWG and an SAAO project team was formed. This project consumed the majority of

effort in the Division and culminated in the Preliminary Design Review held on 26 February 2002. External reviewers from the University of Texas at Austin (McQueen) and the Astronomy Technology Centre in Edinburgh (Atad-Etedgui) were present. About a dozen local scientists and engineers also attended. The design was well received and the project was given the go-ahead to proceed to final design review. Two modes of the instrument are envisaged: Verification Instrument Mode (VI mode) and Acquisition Camera and Science Imager Mode (ACSI mode). The former is intended to enable the SALT Project Team to check the performance of the telescope. Delivery of VI mode is to a very tight schedule and is to take place by the end of March 2003. A contract between the SAAO and the SALT Foundation has been signed and will govern the technical aspects, budget and schedule of the instrument.

F3(c) Prime Focus Imaging Spectrograph (PFIS)

SAAO was appointed to provide the detector package for the Prime Focus Imaging Spectrograph (PFIS) being built at the University of Wisconsin. The same project team as for SALTICAM began work in May 2001. Design work was carried out and this culminated in the Preliminary Design Review at the University of Wisconsin in October 2001. Three external reviewers, Hill (Texas), Barden (NOAO) and Taylor (Caltech) were present, along with the majority of the SALT SWG. The detector package design was accepted, more or less without criticism. A Memorandum of Under–standing between SAAO, the University of Wisconsin and the SALT Foundation has been signed by all three parties which will govern the technical aspects, budget and schedule of the detector package.

F3(d) SALT Autoguiding

J Menzies collaborated with the SALT Project team in analysing and specifying the requirements for the guiding and focusing system on SALT. This involved modelling the transmission of flux from a star through the atmosphere, telescope optics and guiding/focusing system. A presentation was made to the SALT SWG, after which some refinements were made to the proposal. A satisfactory solution appears to have been achieved, which will be tested with actual hardware late in 2002.

F3(e) HET Collaboration

D O'Donoghue continued his collaboration with J Booth and the HET operations team in order to solve the HET image quality problem. He visited HET prior to the SALT Board meeting in Texas in March 2001. Ten days were spent investigating whether stacking of the primary mirror array could be improved. A negative answer was deduced and Shack-Hartmann stacking was recommended as a replacement technique. This has now been imple–mented and stacking close to specification has been achieved.

F3(f) SALT Science Working Group (SWG)

D O'Donoghue is the South African representative on the SALT SWG and, as such, he attends all meetings of the Group which are held in advance of SALT Board Meetings. Other members of SAAO attend these deliberations from time to time if it is practical for them to do so. In April 2001, the SALT SWG met in Texas and was attended by R Stobie, while in October, the meeting was in Wisconsin and was attended by R Stobie, D Carter and J O'Connor.

F4 ELECTRONICS SUB-DIVISION

Head of Sub-division: G Evans

F4(a) SAAO Sutherland Site Electrical Supply

An electrician from iThemba LABS (formerly NAC) visited Sutherland in April 2001 to install timers and contactors to sequence the site load when switching from mains to generator power. The plateau receives power immediately followed by the hostel and finally the houses. The electrician identified a number of deficiencies requiring attention and provided SAAO with a comprehen–sive report. The SAAO Building & Site Main–tenance Manager is now responsible for carrying out the recommendations.

F4(b) Telescopes

General

1.9-m and 1.0-m telescope electronics are based on Motorola 6809 and Intel 80188 microprocessors housed in SABUS crates. These systems are now about 20 years old and need upgrading to provide additional functionality and allow easy maintenance

of hardware and software. During the year, a variety of solutions were proposed, the most attractive being a host PC networked to a Programmable Logic Controller (PLC), which is interfaced to the encoders, the drive system and the XY-slides. The PC would also interface to the acquisition camera.

Automatic Photometric Telescope (APT)
The zero-point of the absolute encoder on the dome was found to precess if the dome was rotated in one direction. This was caused by the encoder gear ratio of 49:1 not matching the drive pinion/rack slot ratio. It was decided that a software solution would not be robust against system crashes, and that a mechanical solution was required. This involved removing two teeth from the dome rotation rack ring, and adjusting the position on the gearbox correspondingly. The mechanical department implemented this modification, and the problem was solved. Dome performance has been satis–factory since then.

0.5-m Telescope
The RA dial synchronous motor failed and could not be repaired. It was replaced by a stepper motor and a custom designed circuit to drive it at the correct rate.

1.9-m Telescope
The 1.9-m warm room was redesigned to accommodate computers and control panels used in such a way as to allow easy access to everything. In August 2001, the warm room was emptied and prepared new desks and shelves were installed. These modifications were completed in a single working day and no observing time was lost.

An SAAO-designed bi-directional general purpose multiplexer has been installed in the 1.9-m dome. Up to 32 bits of TTL-level data are synchronously sampled, converted to a serial stream and trans–mitted on optical fibre between warm room and telescope. These signals are used for instrument control and status.

Southern African Large Telescope (SALT)
In March 2001, electronics staff were allocated specific portfolios regarding the SALT telescope.

Facility:	P Fourie
Telescope Structure:	A Riddick & P Menzies
Dome:	A Riddick & P Menzies
Primary Mirror:	C Petersen & G Evans
Tracker:	C Petersen
Payload:	D Carter & W Koorts
Commissioning Instrument:	D Carter & W Koorts
Telescope Control System:	E Bauermeister & G Evans

The objective is to understand the specifications, purpose, interactions and maintenance requirements of the allocated subsystems by attending the SALT reviews and reading the relevant documentation.

F4(c) Instruments

Cassegrain Spectrograph
The spectrograph control panel has been redesigned with modern switches and indicators in the form of a mimic panel. The status indicated will now be the true status of the instrument and not just an indication of switch position. To achieve this, additional electronics has been added to the instrument. The system is designed in such a way that computer control of the whole instrument becomes very easy to achieve with the addition of suitable software on the instrument control com–puter. The development of a new Real Time Linux spectrograph control program commenced with the development of a real-time device driver, and a GUI. This work is expected to continue into 2003.

IRP MK III Autobox Upgrade
The upgrading of the IRP Mk III autobox and filter change system on the cryostat has been completed.

F4(d) Projects

Charge Coupled Device (CCD) Projects

San Diego State University (SDSU) II CCD Controllers
Initial work was done with a SUN workstation with an SBUS interface card. Work started last year on transferring software to a PC running Linux with a PCI bus interface card. Because of software difficulties D Carter visited R Leach in San Diego with an SAAO PC. This trip proved to be very valuable. Enough software problems were solved to provide SAAO with a working PC based system.

SALT Imaging CAMera (SALTICAM)
SALTICAM is an astronomical detector based on a mosaic of two $2k \times 4k$ Marconi Applied Tech–nologies CCDs. These CCD44–82 detectors have 15-micron pixels. A Preliminary Design Review was held in Cape Town in February 2002. Presentations were given by D Carter, W Koorts and G Evans from the electronics group.

Prime Focus Imaging Spectrograph (PFIS)
This detector consists of a mosaic of three 2k × 4k Marconi Applied Technologies CCD44–82 detec–tors. A Preliminary Design Review was held in October 201 in Wisconsin attended by D Carter from the SAAO electronics group. He presented the electronics design for the PFIS detector system. On his return via London, D Carter visited Marconi Applied Technologies, the UK Astronomy Tech–nology Centre (ATC) in Edinburgh and Rutherford Appleton Laboratory.

Fast CCD Photometer
The CCD detector already purchased for this project is an EEV 47–20 with enhanced broadband coating. The preliminary design has been completed and a Peltier cooler with compatible heatsink has been purchased. The cryostat will be a "drop-in" replacement for the Wright Instruments CCD detector.

SAAO Two-Channel Photo-Polarimeter
All the electronics has been completed and will be integrated into the instrument as soon as it has been manufactured.

The InSb Infrared Camera
The filter wheel drive electronics have been designed, built and tested. Detector temperature control circuitry has been designed and built, but still has to be calibrated.

F4(e) Projects Hosted by SAAO for External Organisations

Sutherland Seismic Station
The Sutherland electronics technicians liaised with the Comprehensive Nuclear-Test-Ban-Treaty Organi–sation (CTBTO) with regard to the installation of a VSAT communication interface to allow direct data transmission to the International Data Centre of the CTBTO in Vienna. The 2.4-m satellite dish antenna was installed together with the network electronics.

South African Geodynamic Observatory Sutherland (SAGOS)
The regular helium fills took place in January and December 2001. Calibration of the super-conducting gravity meter using a portable Absolute-Gravimeter FG5 was done in February 2001.

Infrared Survey Facility (IRSF)
The SAAO technical staff have assisted Japanese colleagues with general maintenance where required. This telescope has been working well.

Yonsei Survey Telescopes for Astronomical Research (YSTAR)
A 10Mbps fibre-optic network connection was installed to the new YSTAR telescope building via the Airglow building.

F4(f) Projects Completed During the Year

- Stepper Motor Driver for InSb IR camera filter wheel.
- SDSU II CCD Controller testing with STE3 CCD.
- IRP Autobox upgrade.
- Transfer of the control of an SDSU II system from a SUN workstation with SBUS I/F to PC (running Linux) with PCI I/F.
- Construction of production model of APD interlocked PSU.
- Investigation of intermittent noise in Dandicam IR channel.
- Calibration of the superconducting gravimeter with staff from GFZ.
- InSb IR camera filter wheel control and tem–perature control I/F.
- Training a new technician for Sutherland.

F4(g) Projects in Progress

- SALTICAM verification instrument and acqui–sition and science imager.
- CCD detector system for the PFIS instrument.
- SDSU II CCD controller software development.
- Design of a fast CCD photometer.
- Design and construction of a two-channel photo-polarimeter.
- Modifications to the CCD system for the grating spectrograph with new camera.
- Telescope and Instrument control – planning for the future as PCs change from EISA to PCI bus cards slots.

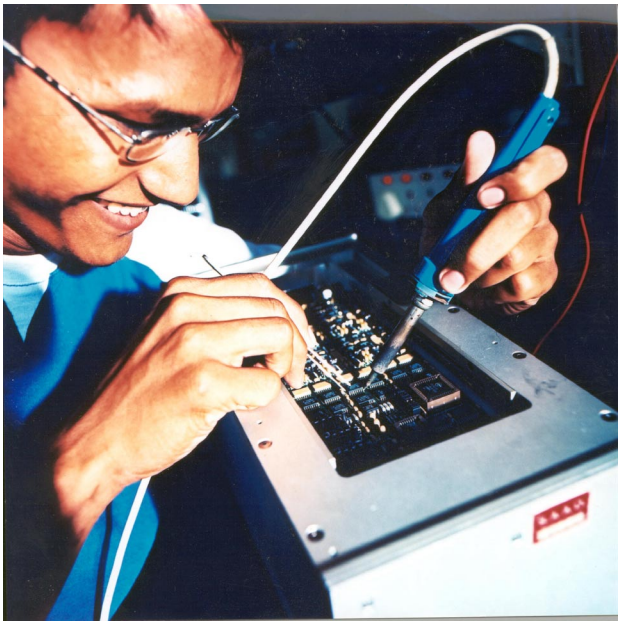
F4(h) Network Installations

The hub in the technical building was upgraded to 24 ports to provide all the offices with one or more network connection points. A 100Mbps link was installed between the hub room and the SALT building. In Cape Town, a 100Mbps sub-network was installed for the mechanical department.

F4(i) Technikon Student Training

Every six months, the electronics section of SAAO selects two students for in-service training from the Cape Technikon or the Peninsula Technikon. The

students are normally employed for a period of 6 months and contributed to a wide range of small projects whilst gaining valuable work experience. To date the electronics department has provided in-service training for 18 students.



M Mosaval busy in the electronics laboratory (photograph SAAO)

From January to June 2001, S Johnson and A Shaik-Allie (Cape Technikon) were employed and involved in:

- Soldering course – construction and testing of a laplink adapter.
- General Purpose power supply 5V, 750mA – construction and test.
- Digital to analogue converter – design, construction and testing:
  – R/2R ladder network design; and
  – design based on DAC 0800 integrated circuit.
- Wind speed and direction system – design and software.
- Capacitance meter design, build and test.
- Design, build and test a network UTP cable tester.
- 1-week trip to Sutherland – various tasks.

From July to December 2001, G Gqomfa (Peninsula Technikon) and S Johnson (Cape Technikon) were employed and involved in:

- Soldering course – construction and testing of a laplink adapter.
- Design and construction of an interface for a PCI 6602 digital I/O counter card.
- Design, construction and test of an ECL to TTL converter.
- Design, build, write the software and test a network UTP cable tester based on a PIC microcontroller.
- 1-week trip to Sutherland – various tasks.

In January 2002, M Mosaval and N Nkuna (Cape Technikon) commenced their in-service training at SAAO. As part of their work, they reviewed and improved the designs and constructed circuits of previous in-service trainees.

F5 MECHANICAL SUB-DIVISION

Head of Sub-division: J O'Connor

F5(a) General

During the year, some changes took place within the department. S Baloyi left SAAO to return to his former field of employment. At the end of 2001, two technicians relocated: S van der Merwe came to Cape Town and J Stoffels moved to Sutherland. It is expected that both these moves will strengthen the capabilities of the department. It is also expected that the manufacturing workload will increase substantially in the coming year, reasons for this being the polarimeter design that is nearing completion and the expected SALTICAM manu–facturing work that needs to be completed early in 2003. F Osman (Btech graduate) joined the organi–zation in December on a 2-year contract to assist with the additional workload during the develop–ment of the SALT instrumentation.

F5(b) Design

The implementation of the IDEAS CAE software has been a steep learning curve, but the mechanical workshop was fortunate in having the capabilities of S van der Merwe to assist all involved. The design of the SAAO Two-Channel Polarimeter was completed during the period under review.

F5(c) SALT

The department is involved with SALT in various ways, the most notable of which are the following:

Design of PFIS Cryostat

The proposals at the PFIS Preliminary Design Review in Wisconsin during October 2001 were very well received. The final design for the cryostat will now go ahead, with the Final Design Review scheduled for January 2003.

Design of the Mechanics for the 2 Modes of SALTICAM
Acquisition Camera and Science Imager (ACSI) mode and Verification Instrument (VI) mode.

The Preliminary Design Review of SALTICAM took place in February 2002. This review was held in Cape Town with international reviewers attending. Once again, the department received favourable feedback on the proposed designs.

F5(d) Projects

SAAO Two-Channel Polarimeter
As mentioned, substantial progress was made on this project that should see manufacturing commence early in 2003.

SALTICAM
The bulk of the design focus was on this project during the latter half of the reporting period and a substantial workload is expected in the future.

Yonsei Survey Telescopes for Astronomical Research (YSTAR)
The building for this telescope was erected in Sutherland using local contractors overseen by the department.

F5(e) Maintenance

Maintenance at Sutherland is still a very high priority, even though very little progress was made on the intended integrated maintenance plan. This aspect will, however, be addressed once there is more information available on the SALT equipment and the design workload has eased off. The existing equipment was properly maintained and attended to during the past year. Maintenance in Cape Town was focussed on preventing the old telescopes on site from deteriorating. Most attention was given to the McClean, more specifically the hydraulic system.

F5(f) Projects Completed During the Year

1.9-m Telescope

- Mobile working platform completed as a student project.
- Mobile ladder completed as a student project.
- The lower edge of the dome was extended to stop water being blown in during rainstorms.

1.0-m Telescope

- Effort went into resolving problems with the dome rotation gearboxes including replacing an incorrect ratio on one of the drive gearboxes.
- Modification to the adjustment mechanism of the acquisition camera.
- Modification to the SSR brackets.
- A bracket was manufactured for the operator handset.

0.75-m Telescope
Dome rotation mechanisms received attention.

- Pre-loading mechanism was developed for the RA drive. This mechanism will need further investigation and development during the year.

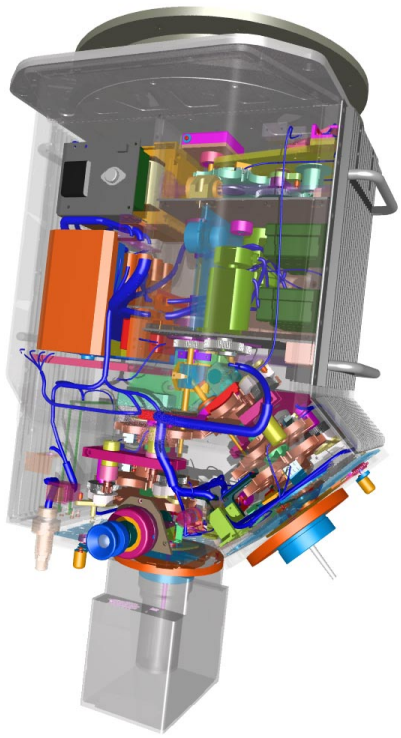
0.75-m APT
J Stoffels devised a plan and modified the dome drive to correct the errors in positioning.

Infrared Survey Facility

- A rubber skirting was fitted to the dome to stop water ingress during adverse weather conditions.
- Manufactured brackets and plugs for the mirror cleaning facility.

Yonsei Survey Telescopes for Astronomical Research (YSTAR)

- Additional modifications were done to the base plate, trapdoor and access ladder.



The Polarimeter (designed by J O'Connor & S van der Merwe). This instrument is unique because of its two channels. The design is very impressive due to its compactness and ergonomics.

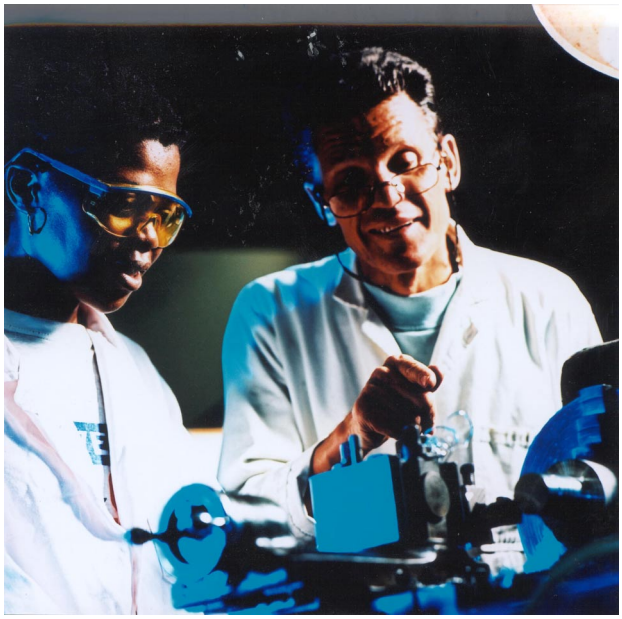
Unit Spectrograph
- Occulting mask for dekker mechanism.
- Bracket for the dewar.
- Manufactured components for mounting new slit optics.
- Modifications to the filter slides.

Infrared Photometer
E Sommeregger designed and manufactured Geneva drive mechanisms for the aperture and filter wheels.

Dandicam
A new cover was manufactured and fitted to the electronics module in order to overcome electrical interference problems.

F5(g) Projects in Progress

Polarimeter
This project has had its design phase completed except for the APD mounting which still requires some design effort. Manufacturing has commenced, but will come to a temporary halt for twelve months due to SALTICAM work.



E Sommeregger training Cape Technikon student, J Siphuka (photograph SAAO)

SALTICAM
The preliminary design phase was completed successfully. The final design will commence with manufacturing scheduled to start towards the middle 2002.

PFIS Cryostat
The preliminary design phase was completed with the final design scheduled to commence during the latter half of 2002.

F5(h) Student Training

The department had two technikon students for experiential training. During January 2002, the curriculum was modified to include ideas training in 3-D modeling, as well as restructured workshop modules. Students undergo basic development for the first 3 months after which they are actively employed on departmental projects.

The students were actively involved in the following projects:

- The working platform in the 1.9-m dome.
- The mobile ladder in the 1.9-m dome.
- The Geneva mechanisms for the infrared photometer.
- Fitting of the weatherskirts to the IRSF dome.
- Designing and manufacturing 2 cropping tools for the fly presses.

In addition to training on the premises, the department is also involved on the Advisory Committees of both the Peninsula Technikon and the Cape Technikon Schools of Mechanical Engineering.

At the SAAO Sutherland, J Stoffels volunteered to give mathematics lectures after hours in his own time to scholars of the local school, a gesture which is very much appreciated.