Minutes of the 4th SALT Science Working Group meeting

29 & 30 August 2000

SALT Meeting Room
SAAO, Cape Town, South Africa

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6 February 2001

The fourth meeting of the SSWG took place on Wednesday and Thursday, 29 & 30th August 2000, in the SALT Meeting Room of the SAAO, Cape Town, South Africa.

1. Participants

Members:
David Buckley (Project Scientist, Chair)
Peter Cottrell (NZ, proxy for G. Mackie)
Klaus Fricke (Goettingen)
Richard Griffiths (CMU)
Janusz Kaluzny (Poland)
Ken Nordsieck (Wisconsin-Madison)
Darragh O'Donoghue (South Africa)
Larry Ramsey (HET)
Anne Sansom (UK Consortium)
Ted Williams (Rutgers)

Ex-officio attendees:
Gordon Bromage (UCLAN)
John Butler (Armagh Obs.)
Dave Carter (SAAO Electronics)
Chris Clemens (U. of North Carolina)
Leon Nel (SALT Payload Manager)
Kobus Meiring (SALT Project Manager)
Bob Stobie (Chair of SALT Board)
Arek Swat (SALT Optical Engineer)
Gerhard Swart (SALT Systems Eng.)
Eric Wilcots (Wisconsin)

2. Welcome and Minutes of the previous SSWG meeting

Participants were welcomed, particularly the UK representative, Anne Sansom (UK), who was attending for the first time, and Chris Clemens (UNC), who was present following the recent expressions of interest of North Carolina becoming a SALT partner.

Several Action Items arose from the minutes:

- Klaus Fricke to investigate Göttingen's possible instrument involvment (see report)
- SAC trade-off study (see report from Ken Nordsieck)
- PFIS trade-off study ("   ")
- UCHRS feedback (see report by Peter Cottrell)

The minutes were accepted with one minor typographical correction ("focal ration").

3. Report from Chris Clemens, University of North Carolina

Chris Clemens summarized the background to UNC's recent overtures to join the SALT collaboration. UNC are a major partner in the 4-m SOAR project, with a total capital contribution of ~$9M. This Southern Hemisphere telescope is optimized for good imaging, and UNC's desire is to have the capability of spectroscopic follow-up, e.g. with an 8 to 10-m class telescope, for which SALT is eminently suited.

Science needs for a 10-m

The following is a list of UNC science drivers requiring a 10-m telescope:

- NIR spectroscopy at R~30,000 – 40,000 (e.g. Cepheids)
- Detecting White Dwarf companions to pulsars
- Optical photometry of pulsars (to V~26)
- AGN host galaxies
  - Host galaxies with IFU
  - R ~ 4,000 – 12,000
  - Tuneable filter imaging
- QSOs and nearby cluster galaxies
- Time-resolved spectroscopy of WDs (R ~ 5,000 – 10,000)
- Mass-Radius relationship determination for lower M-S
  - Equation of state is poorly modeled
  - Look for eclipsing systems _ R.V. curves (R ~ 30,000)
- Dynamical studies of low-intermediate *z* galaxies
- Some needs for I & R capability, but no strong JHK needs

Partnership & finance issues

UNC has a campaign to raise ~$1.5B, at ~$165M per year and would like to raise ~$3.5M for SALT, with $2M in "cash" and ~$1.5M as an "in-kind" being the most desirable breakdown.

Instrumentation Interests

Current instrumentation interests and experience relate to SOAR instrumentation, e.g. the Goodman Spectrograph. This instrument will be optimized for blue performance, and will have high time resolution capability. It will employ VPH (Volume Phase Holographic) transmission gratings and will utilize UV-transmitting optics (e.g. NaCl). These attributes are very similar to those for the SALT PFIS (Prime Focus Imaging Spectrogaph), and there is an obvious overlap of interest (this was further discussed outside the meeting).

Substantial donations have led to the establishment of the Goodman Instrument Laboratory at UNC, with a full-time Draftsperson and graduate student(s). Current experience is with teaching instruments, but also the aforementioned SOAR spectrograph, and design/testing of VPH gratings for use in that instrument. There is also a budget of ~$50K to build a small imaging telescope for wide-field CCD photometry. Chris Clemens has also succeeded in attracting $1.4M in grant money from various agencies for instrumentation.

4. Reports from SALT partners

HET Status (Larry Ramsey)

HET has been in science operations for 2 weeks per month for the last ~ 9 months. Some 25-30% of the available observing time can be attributed to "shutter open", i.e. collecting science photons. The low efficiency is mainly due to the following:

- Mirror stacking times
- CCD readout overheads

The current low image quality of EE(50) = 2.3-2.5 arcsec is most likely due to contributions of many small errors, rather than one single source. Dome seeing certainly does not appear to be a major source of error. The intrinsic image quality of the HET, in the absence of seeing and stacking errors, is ~1.3 arcsec (cf. to the specification of 0.6"). In practice, segment stacking errors and de-stack conspire to produce a typical best IQ of ~1.8 arcsec. Results from Hartmann tests on individual segments give a median EE(50) of 0.25", indicating that there is no problem with the individual mirror figuring (EE(50) specified to be < 0.39 arcsec).

The M4 mirror in the SAC was re-aligned after it was discovered to be misaligned by ~60 arcsec in tip/tilt.

The CCAS instrument (shearing interferometer) is close to working, and has been tested on a 7-segment sub-array, which has maintained a stack at CCAS of 0.7-0.8 arcsec for several hours.

There has been a ~10 week slip in the SAMS (edge sensors) schedule. The 7-segment sub-array will be tested in Oct. The proof-of-concept was successful.

Commissioning of HRS is expected to begin in late September. There has been a problem with breakage of the 600_m fibres at the vendors (Polymicro).

An IR camera, J-cam, capable over 0.9-1.6_m (0.9-1.3_m in a single exposure) will shortly be installed on a fibre-fed échelle spectrograph (R ~ 10,000-12,000). Future plans include a relatively cheap "dispersive interferometer" which will have m/sec velocity precision.

A total of 12 science papers based on HET observations have recently been submitted. Many of these have been spectroscopic follow-up of the SDSS (Sloan Digital Sky Survey).

New Zealand (Peter Cottrell, University of Canterbury)
Peter reported on the response to the SSWG comments on the Concept Proposal for a High Resolution Spectrograph, presented at the last SSWG meeting. A letter had been sent to the SSWG Chairperson from the NZ representative, Glen Mackie. It was a agreed that there needed to be further consultation with the wider SALT community regarding the desired parameters of the spectrograph (e.g. resolution, wavelength coverage). To this end a draft questionnaire was tabled, which would be distributed to all the SSWG members.

Göttingen University (Klaus Fricke)
The observatory workshop will be tied up to at least mid-2001 with work on OmegaCam (for the VLT Survey Telescope) and instrumentation for the Tenerife Solar Telescope (for Solar Physics group).

Harald Nicklaus (involved in the HET LRS and FORSI & II) will likely be committed to existing projects until 2002. There was, however, still the possibility of involvement by Göttingen in SALT instrumentation, particularly later, and particularly for the SALT Fibre Instrument Feed. Precision mechanics could be undertaken in the Göttingen workshops, which could be made available (e.g. to Nicholas Sessions).

Rutgers University (Ted Williams)
Ted reported on the continuing interest in Fabry-Perot etalons, and particularly their role in this aspect of the PFIS. He also mentioned that Rutgers and Columbia University were investigating the possibility of setting up a joint program in investigating VPH gratings.

Poland (Janusz Kaluzny)
A conference was held in mid-May to discuss SALT science drivers and instrumentation issues.

South Africa (Darragh O'Donoghue)
No developments to report here. A total of two questionnaires had been sent out soliciting opinions on SALT's instrument complement.

UK Consortium (Anne Sansom)
Anne presented a summary of the membership of the UK SALT Consortium (UKSC) and their science needs, summarized as:

- High spectral resolution (50,000)
- High time resolution (~ 0.1 – 1.0 sec) for flare/active stars, CVs, accretion powered systems.
- Multi-object spectroscopy (e.g. supporting X-ray identifications).
- Some near-IR/IR capability (jets in YSOs; X-ray IDs; galaxies; hot stars; young & evolved stars).

- Capability of observing 'non-sidereal' objects (e.g. comets, near Earth asteroids).
- Some desire of medium res. IFU spectroscopy (galaxy dynamics; stellar pops).

(Details of Anne's presentation have been placed on the SALT website under the SSWG in the 'Science and Instrumentation' section (www.salt.ac.za/science/restricted).

Time resolution & instrument parameters
Following on Anne's presentation, Ken Nordsieck enquired how fast was 'fast' for spectroscopy. This will drive the system architecture for PFIS. The time resolution question needs to be addressed in the instrument-specific questionnaires, which will be sent to all the SSWG representatives. They in turn would distribute them to their own SALT user communities. Three such questionnaires will be compiled and sent out:

- UCHRS — G. Mackie/P.Cottrell (also see Peter's report later)
- PFIS — K. Nordsieck
- SALTICAM — D. O'Donoghue

Carnegie Mellon University (Richard Griffiths)
Nothing new to report. PFIS will satisfy CMU science needs.

Wisconsin (Eric Wilcots)
A document, prepared by Jay Gallagher, covering a sample of science programs which would be carried out at Wisconsin with PFIS, was tabled and has been subsequently placed on the SSWG webpage (www.salt.ac.za/science/restricted).

The approach is to identify those programs which benefit from the unique opportunities offered by PFIS, namely:

- Good blue/UV throughput
- Polarization capability
- Fabry-Perot imaging
- Higher resolution spectroscopy (c.f. LRS on HET)

Such programs include:

a.) asymmetric mass ejections from stars
b.) star-ISM connections
c.) structure evolution of galaxies

Wisconsin has offered to host future combined SSWG & Board meetings (it was subsequently decided at the Board meeting that this would happen in September 2001).

5. Discussions on the Spherical Aberration Corrector

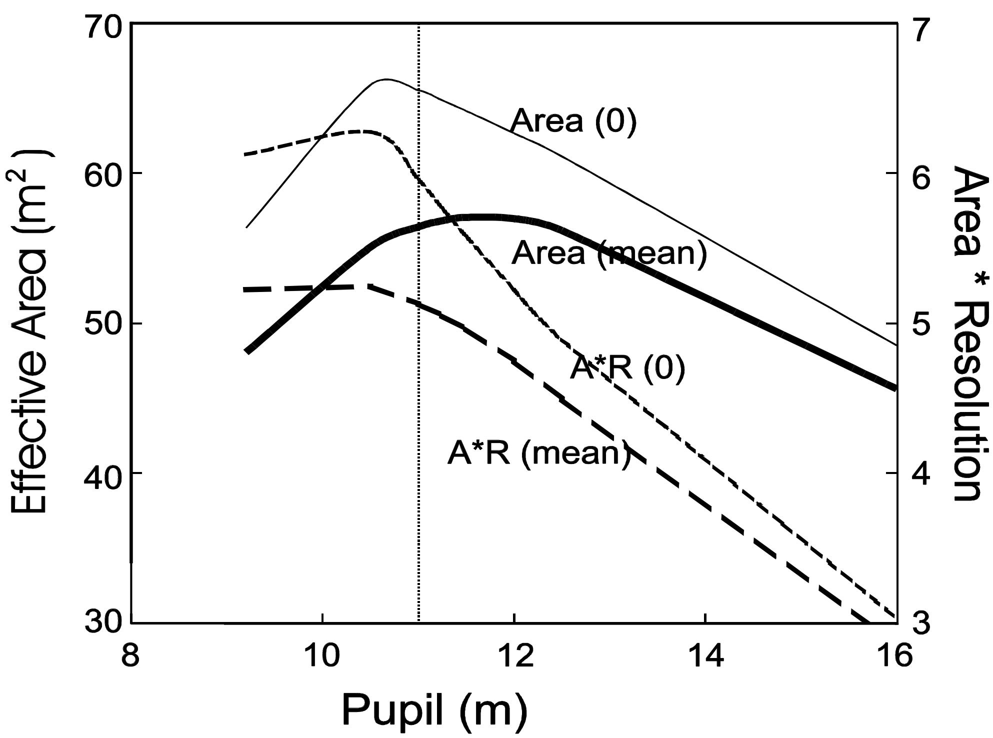
Darragh O'Donoghue discussed the additional grid of SAC designs he did following the last SSWG meeting. These were for pupil diameters of 10.5, 11.0 and 11.5 metres, SAC mirror diameters of 500, 560 and 625 mm, and f/ratios of 4.6, 4.03, 3.84 and 3.67. The degree of on-axis vignetting (~20%) was basically the same for all the designs, while the off-axis losses were as much as 40% for the larger pupils with smallest SAC mirrors (e.g. 11.5-m pupil and 500 mm M2 mirror). Of greater concern is the image degradation for the largest pupils, where EE(80) at maximum field angle (i.e. 4 arcmin) is 0.25 arcsec for pupils ≥ 11.0 m, with a 500-mm diameter M2. These idealized design values will in practice be larger due to manufacturing and alignment errors.

The overall conclusion was that if the largest SAC mirrors (i.e. M2) are kept to a maximum diameter of 500 m, then unacceptable image quality, and increased difficulty of manufacture, would result for pupils larger than 10.5 m. Larger SAC mirrors, which would assist in ameliorating the manufacturing difficulties, are likely to incur non-linear increases in cost and would be impossible to coat with the existing LLNL facility for protected Al/Ag coatings.

Chris Clemens commented that, from discussions with Gerald Cecil (UNC), it is more likely that costs would escalate after a particular size was reached, rather than a strictly defined power law, or whatever, canonical price-diameter relationship.

Additional comments were made concerning the desirability of having a single vendor fabricate, assemble and align the entire SAC. Residual errors in the manufacture of any single mirror can be corrected if the corresponding mirrors are figured in series.

Ken Nordsieck then presented some of the results of his PFIS trade study, that dealt with the optimal pupil size (see figure below). He used a figure of merit based on the product of the effective primary mirror area and the spectral resolution. This 'Merit Function' was at a maximum for pupil sizes of ≤ 10.5-m, while the effective area alone was near maximum for an 11.0-m (tracker on-axis) or 11.5-m (for the average of all tracker positions) pupil. The resolution was seen to be inversely proportional to pupil size, leading to a steeper fall-off in the merit function with pupil diameter.



Larry Ramsey noted that the time-varying asymmetric pupil would also have a significant effect.

Ken's analysis included a study of the image quality (IQ) as a function of pupil diameter and f/ratio. He used Darragh's SAC designs for f/4.6 (10.0, 10.5 & 11.0-m pupils) and f/3.85 (11.0-m pupil). The PFIS optical design was then optimized for best slit focus, including the SAC vignetting, but not aberrations, which produced little net difference. In general, Ken preferred a larger pupil, and slightly faster f/ratio from the perspective of filter sizes, and suggested an 11.0-m pupil at f/4.2.

Pupil images at the slit would be very complicated (varying pupil geometry). Darragh mentioned that there were no big differences in pupil effects in terms of image spot centroiding with the HET.

Leon Nel reported on the results to date from the SAC concept work and RFI (Request for Information) to various potential SAC vendors. In terms of effective area increase over the baseline 9.2-m, the new SAC designs, with 10.5 or 11.0-m diameter pupils, gave an increase of ~18% in effective area. Cost increases, from the RFI information, were ~20% for these larger pupil designs. Larger diameter SAC mirrors (e.g. 625 mm M2) would be easier to manufacture (with less steep curves) and would have better vignetting characteristics. A decision also needs to be made on which parameters are most important. Clearly the f/ratio is *not* a very significant parameter impacting the PFIS design (at least within the current likely values of 3.8 < f/ratio < 4.6).

Some RFI budget estimates for a fully assembled SAC are $908K (REOSC) and $1.7M (Brashear).

6. SALT System Specification

Gerhard Swart (SALT Systems Engineer) gave a brief overview of the SALT System Specification process, which is the technical implementation of the SALT Science Requirements, determined by the SSWG.

Some minor changes were discussed:

- Changing, where appropriate, the minimum operating temperature from -5ºC to 0ºC. This impacts the primary mirror error budget, since the effects of CTE become more pronounced in Zerodur for temperatures < 0ºC.
- There is currently only a single value for IQ over the whole science FoV, with EE(50) < 0.2 arcsec specified for the SAC. Current indications from vendor responses to RFIs indicate a potential cost & risk implication if this is not relaxed. The suggestion was to have two IQ values specified, for field angle of < and > 2 arcmin.

The status of the SALT error budget was also summarized by Gerhard, who also presented the result from Arek Swat's (SALT Optical Specialist) analysis. There were a number of items still to be investigated. The issue of wind shake was discussed, with Larry Ramsey saying that no wind shake of the HET structure has been detected (e.g. when observing directly into 70 mph winds). High frequency oscillations were also not present, judging from the 60Hz video camera, which failed to detect any shaking motion. The camera's scale was 0.2"/pixel, and ruled out amplitudes of >0.5". The existing error budget has a 43_m wind-induced deflection for the telescope, which mostly resides in the tracker bridge and/or tracker/structure interface.

7. The Prime Focus Platform concept

Leon Nel (Project Manager of Tracker and Payload) gave an overview of the current PFP concept. The total payload mass is planned to be 750 kg, compared to the 450 kg specified for HET (goal of 640 kg). This figure includes:

- SAC (i.e. all optics, mounts, baffles and assembly)
- Tracker Optical Package (include acquisition and guiding cameras, fibre feed)
- Science instrument (i.e. the LRS)

Ken Nordsieck suggested that a wavefront sensor (e.g. an off-the-shelf AOA *Wavescope* device at ~$40K would be a valuable tool.
Chris Clemens mentioned SOAR would be using a quad-cell guiding system on an *r,* _ positioner. Details could be obtained via Tom Sebring (SOAR Project Manager).

Larry Ramsey raised the issue of the non-flat pupil, which is considerably more curved in the SALT SAC design compared to the HET. It would be important to determine the amount of acceptable vignetting for a flat pupil mask moving over a curved pupil surface. David Buckley raised the possibility of having a curved pupil mask (i.e. moving over a spherical surface of the same radius of curvature).

The fibre feed system, as currently envisaged, would be fed by a 45º insertable mirror, nearly opposite to the similar mirror feeding the acquisition camera, *SALTICAM*. Both mirrors could be mounted on a moving shaft.

8. Progress report on the PFIS

Ken Nordsieck presented a progress report on *PFIS* (the PowerPoint presentation can be downloaded from the SSWG restricted webpage www.salt.ac.za/science/restricted/). The report covered:

a. Status of definition study
b. Optical tradeoff results (presented in Section 5)
c. Mechanisms and control
d. Structure
e. Budget

Work was still progressing on the development of the structure and electronics concepts in order to define the basic interface requirements for the PFP (i.e. mass, space envelope, power requirements, cabling, etc).

The effects of varying pupil size and *f*-ratio on *PFIS* size (and cost) performance were investigated in the optical trade-off study. The results will guide the future design definition work on PFIS.

Further work will proceed on more accurate cost estimates, with margins, for the concept and construction phases. This phase is expected to be completed by November 2000, at which point approval will be sought to proceed to a full concept design, involving some expenditure.

Following discussions with SAAO (Darragh O'Donoghue, et al.), frame transfer Marconi CCDs were now being considered for *PFIS*, i.e. the same type as being used in *SALTICAM*, the acquisition camera. This would incur <10% increase in cost if 4 or more chips were bought and would greatly improve the capability for time resolved observations.

Design update:
The optical design has evolved, with the following changes:

- Wavelength coverage extended to cover 320-900 nm.
- Field flattener thickness decreased to 8 mm (driven by crystal cost/availability).
- The camera length has been constrained to 625 mm.
- Three elements have been dispensed with (including an entire doublet) from the camera design.

Image quality vs. pupil and focal ratio:
Indications are that the f/ratio plays a minimal part in overall image quality, while there is a small improvement (10%) for increasing pupil size (10.5 to 11.5 metres). Image quality curves were also shown for various VPH gratings. The image spot radii values were typically (without refocus):

- mean 0.25 arcsec
- worst 0.40 arcsec

The PFIS system images at higher dispersions improve substantially with refocus. Image quality, as delivered by the collimator, needs to be good to ensure no degradation for a possible future upgrade to an IR arm.

Mechanisms & Control
A table summary of the required motions and suggested methods, involving both motors and pneumatics, was shown. Current software concepts involve using LabVIEW under Linux and would have to be integrated with the CCD control. I/O would be a distributed system of commercial backplane control modules multiplexed to serial cable or ethernet.

It is currently envisaged that there will be two Workstations for PFIS, one for the instrument control and the other for CCD control and data acquisition. The latter would be developed at SAAO, probably not using LabVIEW. Chris Clemens mentioned that SOAR CCD control code might be available to use.

A jukebox arrangement is being considered for the slit masks and filters (containing ~50 slit masks and 20 filters per magazine).

PFIS structure:
First attempt at modeling the structure has assumed a similar deflection specification as for the PFP instrument mounting point, namely < 6_m (over a ± 6 degree tracker trajectory). The total mass of the *PFIS* (visible beam) is currently < 250 kg. The required stiffness of the structure, while at the same time having the capability to articulate the camera, is a potential problem from the point of view of complexity and cost (potential

requirement for composite materials). This will hopefully be mitigated by relieving the specification, to a degree, requiring an optical sensitivity study (in progress). Alternative camera articulation geometries are also being investigated.

The articulation will be achieved using a worm drive.

An out-of-plane design is being investigated to avoid the camera coming too close to the focal plane area (i.e. when at the maximum articulation angle). This could improve the space availability for the collimator mechanisms and would make it easier to incorporate two beams (e.g. for the IR beam upgrade).

Budget
One of the still to be completed definition phase tasks is a detailed budget. Funds will be required to complete the definition phase and begin the preliminary design. Current requirements are (in 2000 dollars):

Funding through to March 2001 Board meeting:	$179K
Funding to PDR stage:	$367K

(This was discussed later at the Board meeting where it was agreed that any such costs would be favourably assessed in terms of the Wisconsin in-kind contribution.)

Preliminary Design SOW:
The following is a summary of the Statement of Work (SOW) for the preliminary design phase of PFIS.

- Tradeoff studies establishing baseline design and specs, which will culminate in a PDR in September 2001.
- Interface requirements to the PFP
- Tradeoff alternative truss designs and establish baseline mechanisms
- Optical design tradeoffs versus science requirements
- Optical sensitivity analysis
- Establish baseline control and software requirements
- Develop an accurate cost estimate for a comprehensive design and construction
- Send out a *PFIS* questionnaire to potential users to gauge opinion on design parameters (e.g. resolution, wavelength coverage).

Current partners identified in the project include:

SAAO	CCD detectors
Rutgers	Etalons and mechanisms
UNC ?	VPH gratings ?

9. Progress on SALTICAM definition

Darragh O'Donoghue gave a status report on *SALTICAM* (this presentation and the *SALTICAM* proposal are posted on the Science and Instrumentation webpage www.salt.ac.za/science/index.html).

The science goals for the instrument still needed defining, and this aspect of SALTICAM (as opposed to its commissioning and acquisition role) would need to be funded from the SALT instrumentation budget.

SALTICAM will be placed further 'up stream' on the optical axis, with a 45º mirror of ~230 mm diameter. This leads to larger optical elements, but less steep curvatures and hence better optical performance.

Guiding:
Guiding issues needed to be resolved. It was not possible to have pick-off guide probes in front of the first element because of the substantial vignetting that would result. There is also not a great deal of room near the focal plane. The image quality off-axis (i.e. outside of the 4 arcmin radius science FoV appears to be sufficiently good to allow for guiding in an annular region out to 5 or 6 arcmin radius.

SALTISIM: a simulator
Darragh also presented a design for *SALTISIM*, a SALT optical simulator comprising two spherical mirrors of 800 and 180 mm diameter, plus a set of field lenses. This device could simulate the f/4.6, ~100mm diameter, input beam of SALT for any instrument, as well as potentially incorporating a moving pupil at the smaller (convex) mirror.

Cost estimate update:
The current cost estimate for *SALTICAM* amounts to $424K, inclusive of labour but exclusive of *SALTISIM*, which is likely to cost of order $80K.

Specifications:
Richard Griffiths suggested that the advantages of *SALTICAM*, as a science instrument, be listed and compared to the likely performance of *PFIS* in terms of imaging and photometry. Darragh agreed to produce a questionnaire, similar to those being considered for the other major science instruments (*PFIS* and *UCHRS*), in order to gauge from the potential user community what the instrumental requirements should be, *in its role as an imaging science camera*. It was also important that the Project Team determine the high level requirements for *SALTICAM* in its alternative role, as an acquisition system and commissioning instrument, the latter required to verify SALT's imaging quality (e.g. as functions of wavelength, exposure time, tracker position, field angle, etc), tracking and pointing accuracy. This will be undertaken by the Project Scientist and Systems Engineer (i.e. David and Gerhard).

10. CCD detector development at SAAO

Dave Carter (SAAO CCD engineer) gave a brief overview of the work involved to date on the detector development for both *PFIS* and *SALTICAM*. The current cost estimates for the complete CCD systems are ~$430K each.

It was clear that if SAAO were to take on the contracts to build the CCD detectors for *PFIS, SALTICAM* and probably *UCHRS* too, that additional staffing would be required in the SAAO technical section. This would be partly to alleviate the work-load on the current CCD team by off-loading non-CCD development work.

Experience is being gained in using SDSU II controllers using AC coupling. Cable lengths needed to be kept very short. The SITe CCD used in tests required the video cable length to be kept to 200mm for acceptable performance, which is an impossible restriction in the context of PFIS. In general video signal cable lengths need to be kept as short as possible (the controller design specification is for it to function acceptably with cables up to 1-m long with EEV CCDs). DC coupling is an alternative and has been implemented successfully at CTIO using 400 mm cable length. An external preamp mounted close to the CCD is also under consideration.

11. Fibre Instrument Feed: a concept proposal

David Buckley presented a concept proposal for a Fibre Instrument Feed (FIF) for SALT, which he and Nicholas Sessions (Mech. Eng. Masters student supervised by David) had written (this document can be downloaded from the SALT Science & Instrumentation webpage: www.salt.ac.za/science/index.html). The premise was for a similar FIF system as in the HET, but for a FoV of 8 arcmin diameter. Since the nature of the first-light fibre-fed instrument was still to be determined, it was difficult to specify the details of the fibre-feed that would need to support it. The approach taken was to define a generic FIF, which in principal could support the same type of fibre-fed spectroscopic instrumentation suite as the HET's. Once the nature of the *UCHRS* is better defined, it will be possible to do more detailed design. Some up-grade path, in support of future fibre-fed instrumentation, should also be considered.

The issue of correcting for field varying telecentric angle was discussed, with the option of removing this by employing a doublet, as suggested by Darragh O'Donoghue, being the proposed solution at this time (although with probably no MOS capability for the *UCHRS*, this may not be an important issue for first-light).

The fibre characterization work carried out by Nicholas Sessions, under the supervision of Larry Ramsey, at Penn State, was also presented. David expressed his gratitude to Larry for generously hosting Nic for ~5 months. Included were the result of his pupil simulation work, which showed the effects on both the near- and far-field images, after the injection of vignetted pupils into 400_m fibres. Azimuthal scrambling was extremely efficient at removing all asymmetric pupil effects, while radial scrambling did lead to variations in the far-field profiles, by as much as 35% when comparing flux in the central 'trough' (resulting from the central obstruction) to that in the peak. Larry commented that this effect, combined with the optical aberrations of the spectrograph, leads to potential variations in the line profiles as a function of the tracker position. For certain types of demanding observations (e.g. precision radial velocities), the effect will need to be accurately accounted for, and as a worst case this could mean such observations may be impossible. It was agreed that the effects needed to be assessed in terms of the final parameter space that *UCHRS* would operate in. Resolution would be the parameter likely to be impacted by this.

Project Management:
It was proposed by David that he would be the Principal Investigator for the FIF, with Nick Session's being appointed as the Project Engineer. Much of the work could be undertaken at the SAAO, but there was also room for SALT partners involvement (e.g. the proposal from Göttingen for some of the fine machining to be undertaken in their workshops). Nicholas was currently working at the HET until end of November, at which

time he would return to Cape Town and complete writing up his Master's thesis (on fibre issues) by early 2001, and would be ready to take up an appointment thereafter.

Costs:
The ROM cost estimate for the FIF instrument was $220K and the timescale to complete it ~2.5 years. While an offer of using Larry's lab for some of the fibre testing was attractive, at least for the tests required in the short-term, a fibre-testing rig at SAAO would be desirable in the long term. An ROM estimate for this is ~$5K, and is *included* in the FIF cost. No pupil simulator is included, however, but see comments on *SALTISIM* (previous section).

12. UCHRS: University of Canterbury High Resolution Spectrograph

Peter Cottrell reported that discussions had taken place following the feedback from the the SSWG, sent in a letter to Glen Mackie (NZ SSWG representative) by the Project Scientist, to the original concept proposal (presented at the last SSWG meeting). The points raised in that letter were:

- Science goals needed discussing amongst the wider SALT community
- Fibre size needed matching to plate scale, with implication on R
- No provision for MOS (Multi-Object Spectroscopy)
- Investigation of alternative camera designs / detector formats

A response to this, sent by Glen Mackie, was tabled in which the points mentioned above were accepted. Some of these issues would be addressed in the full concept development (Phase A) stage, which will be completed in mid-2001. In the meantime, a questionnaire would be sent out to canvas the SALT user community on the specific niches that *UCHRS* should fill and the instrument parameters, principally resolution, wavelength coverage and stability, and MOS requirements.

Some discussion followed on the MOS capabilities that could really be achieved with a 'cheap' instrument like *UCHRS* (certainly < $1M). A folded Schmidt design, as conceived by the John Hearnshaw (PI for *UCHRS*), would have no MOS or IFU capability. For IFUs, the required field drives the camera optics design, and leads to difficult and expensive designs. Such a camera is unlikely to be affordable for a first-light fibre-fed instrument.

The consensus of the meeting was that the PI should not be over-pressured into redesigning *UCHRS* to fulfill too wide a list of requirements, but rather settle on a clear set of parameters which best fulfill the science goals and place the instrument in a competitive situation. Specific niches include high-time resolution spectroscopy, coupled with high spectral resolution, and very high precision radial velocities. Some small degree of fibre multiplexing (e.g. a single on-axis 3–fibre or 7-fibre 'bundle' could still be useful in increasing resolution for brighter objects, from the small fibre size), if the camera optics allow.

13. The science requirements for SALT's fibre fed spectrographs

Eric Wilcots continued the discussion on the issues impacting on the choice of parameters for *UCHRS*. He mentioned the expertise at Wisconsin with Integral Field

Units (IFUs), namely the Densepack on WIYN and the IFU for the HET MRS, which Matt Bershady has built.

IFUs:
Some IFU spectroscopy at R = 30,000 to 40,000 could be very useful for abundance studies, e.g. Li _6700 as age indicator.
Multiple IFUs, with 10-30 fibres per object, could be a very competitive instrument. In this case the _-coverage would be sacrificed for MOS, perhaps using only single échelle orders. The use of VPH gratings as efficient, tunable, cross dispersers has also been raised. Configurable IFUs could be designed, which could be stacked together to give more continuous spatial coverage at the center of the FoV.

High Resolution:
It appeared that there were no strong high resolution (R ~ 100,000) MOS requirements. However, high R was an important need for QSO absorption line studies (e.g. Ly_, MgII). Eric will liase with the New Zealanders (i.e. Peter Cottrell, Glen Mackie) in ensuring that their *UCHRS* questionnaire is sufficiently comprehensive.

Positioning Accuracy:
It was mentioned that fibre positioning to 0.05 arsec (i.e. ~ 10 microns) was important for accurate and repeatable spectrophotometric accuracy.

The issue of co-alignment of the PFIS slit-mask and the acquisition camera was also raised. This is an operations issue, and should be discussed in the operational specification. For HET this is apparently not a problem (e.g. with LRS).

Calibrations:
A calibration unit similar to that used for the HET LRS could also work for the *PFIS*, i.e. fibre-illuminated screen at the M3 pupil position. For fibre-fed instruments (i.e. *UCHRS*), this would be quite inefficient, and another system would need to be devised. Fabry-Perot instruments would require flat-fielding to ~1% accuracy.

14. Discussion on SALT's operational requirements

David Buckley and Gerhard Swart (Sys. Eng.) summarized the current status and approach to this task, namely that they were taking the HET Operational Requirements document as a starting point. Those areas which impact the science and instrumentation, or are of potential interest to the SSWG (rather than simply routine operations issues), will be discussed with the SSWG representatives.

Larry mentioned that for HET it took ~ 6 months to fully train their Resident Astronomers and ~3-4 months for the Telescope Operators. For commissioning, a core group of dedicated people are required, with good instrumentation and software skills. The HET Project Scientist appointed a Scientific Commissioning Team consisting of scientists from the partner institutions.

The utility of a software simulator was discussed.

For follow-on (2nd generation) instrumentation, which is critical for the development of SALT, due credit, in terms of guaranteed nights, must be given to the PIs and instrument builders.

Operations time-line:
A draft of the generic operational time-line for a typical night has been produced by Gerhard. This includes all of the telescope operations in acquiring a target and guide star(s), calibrations and the 'shutter-open' time (i.e. instrument exposure time). Similar timelines should also be produced for the individual instruments by their PIs, to be eventually folded in to the overall system timeline.

Gerhard and David would continue developing the operational schedule by populating it with specific tasks. Presentation of information and the requirements for an integrated, but non-confusing, display were also discussed.

Some work would proceed on the requirements for PIs/proposals for SALT observations, again based on the HET, but taking into account practicalities as envisaged with SALT.

15. Potential satellite communications for SALT

Ted Williams discussed the recent development at Rutgers in investigating the possibility of obtaining a (partially ?) donated satellite channel, from a Rutgers alumnus, for SALT data downloads to the mainland USA. He mentioned that this was based on the perhaps erroneous premise that the Sutherland – Cape Town bandwidth was going to be a potential bottle-neck in data transfers. Current data rates were 512 KB/sec, although the capacity of 2MB/sec was available, at a cost of ~$4500 per month.

Raw science data (i.e. CD frames) could amount to 1 – 2 GB per night, which needed to be downloaded in a reasonable time (i.e. « a day). Quick look data, which could be compressed by a factor of ~100, could be downloaded in minutes. Chris Clemens mentioned that SOAR was planned on 10 GB of data per night to be produced.

The issue of bandwidth, data transfer, archiving and PI data retrieval were being considered in the SALT system and network specification, and would be discussed again at future SSWG meetings once the details have been worked out.

16. Other business

Key Programs:
Peter Cottrell raised the issue of possible 'Key Programs' for SALT, whereby SALT partners might collaborate on major observational programs, as happens at other observatories (e.g. ESO Key Programs). Given the importance of certain objects for SALT (e.g. the Magellanic Clouds, the centre of the Milky Way), this approach might be attractive and could guarantee a high profile for SALT in its early days of operation. The counter to this was that HET purposely did not introduce such a scheme, deciding that often the science of these large programs were not that competitive and they should stand up to the normal competitive process, and not be guaranteed large amounts of time. Coordination of the TACs was also a tricky issue.

Opinion appeared varied on the matter, although in general such programs were thought to be a good idea, in principle, provided they were well focused on the competitive edge that SALT will attain in certain areas.

Future Meetings:
The next two SSWG meetings, in April and September 2001, would both be held in the USA. The September meeting would be held in Wisconsin, while it would be proposed at the Board meeting for the April meeting to be held at MacDonald Observatory.

The meeting was concluded and a dinner hosted for the SSWG at the old Cape Town Castle.