THE MESSENGER

EL MENSAJERO

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OBSERVING WITH THE VLT

Science Verification Observations on VLT-UT1 Completed

THE VLT-UT1 SCIENCE VERIFICATION TEAM

Science Verification (SV) observations on UT1 have taken place as planned from August 17 to September 1 (cf. *The Messenger*, 92, 5, for a presentation of the goals and the strategy of SV). Although the meteorological conditions on Paranal have been definitely below average, very valuable data have been gathered and are now being prepared for public release. The tele-

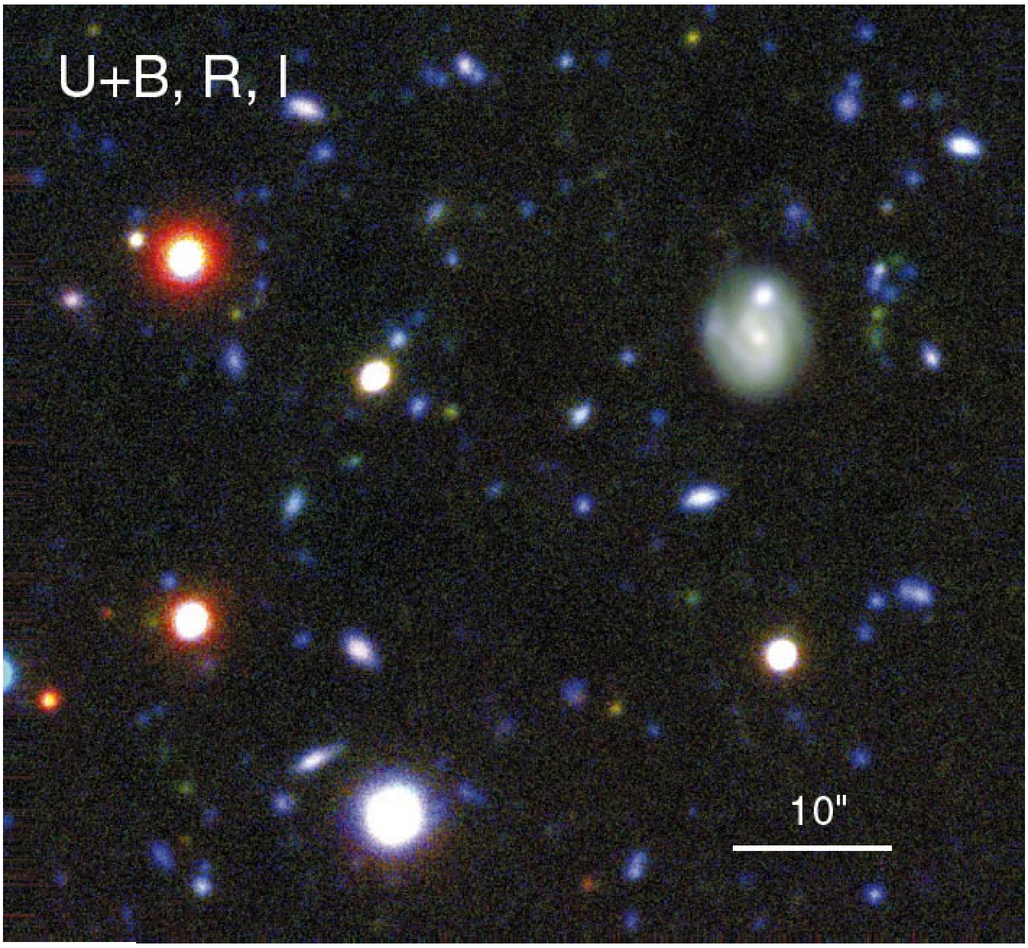


Figure 1: The colour composite constructed from the U + B, R and I VLT test camera images of the Hubble Deep Field South (HDF-S) NICMOS field. Exposure times are given in Table 2 of the editorial. The U + B, R and I images are displayed in the blue, green and red channels, respectively. The image is scaled from a low cut about 1 σ below the peak of the sky noise histogram to a high point which makes the star below the large spiral galaxy approximately white. The spiral galaxy itself has been masked and displayed with a different stretch to keep the internal structure visible.

TABLE 1: Summary of Science Verification Observations.

Programme	Hours	% of planned
HDF-S NICMOS and STIS Fields	37.1	98%
Lensed QSOs	3.2	82%
High-z Clusters	6.2	55%
Host Galaxies of Gamma-Ray Bursters	2.1	56%
Edge-on Galaxies	7.4	65%
Globular cluster cores	6.7	57%
QSO Hosts	4.4	—
SN1987A	0.0	0%
TNOs	3.4	—
Pulsars	1.3	18%
Flats and Standards	22.7	99%

TABLE 2: VLT Test Camera Data on the HDF-S NICMOS Field.

Filter	No. of exposures	Total integration time (sec)	FWHM of the coadded image
U	16	17788	0.71″
B	15	10200	0.71″
V	16	14400	0.78″
R	8	7200	0.49″
I	12	10158	0.59″

scope has been working with spectacular efficiency and performance through the whole period. After having been disassembled to install the M3 Tower, the telescope was reassembled again putting back in place the M1 mirror cell (August 15). The Test Camera was re-installed at the Cassegrain focus on August 16, the telescope was realigned and tested, and finally released to the SV Team at midnight local time on August 17. The first SV observations were promptly initiated thereafter. The SV period ended on the morning of September 1, spanning a total of 142 hours, dusk to dawn. Of these, 44 hours have been lost due to bad meteorological conditions (clouds or wind exceeding 15 m/s), and 15 hours for minor technical problems, with an effective down time of ~ 10%. For a total of 95 hours the telescope has been used to collect scientific data, including twilight flat-fielding and photometric standard star observations.

Table 1 gives the actual time invested on each of the SV programmes, along with their level of completion compared to the initial planning. This includes operational overheads, such as read-out times, target acquisition, etc. For those programmes that could not be completed care was taken to complete the necessary observations for at least one object.

All SV data will be released by September 30 to the ESO and Chilean communities. It will be possible to retrieve the data from the VLT archive, while a set of CDs will also be distributed to all Astronomical Research Institutes within ESO member states and Chile. Data on HDF-S will be public worldwide, and retrievable from the VLT archive. Updated information on data release can be found on the ESO web site at http://www.eso.org/vltsv

Astroclimate During Science Verification

When, at one of the best observatories worldwide, over two weeks and more, the sky is often cloudy, the seeing poor, the wind fairly strong and blowing from unusual directions, one is allowed to start talking of an astroclimatological anomaly.

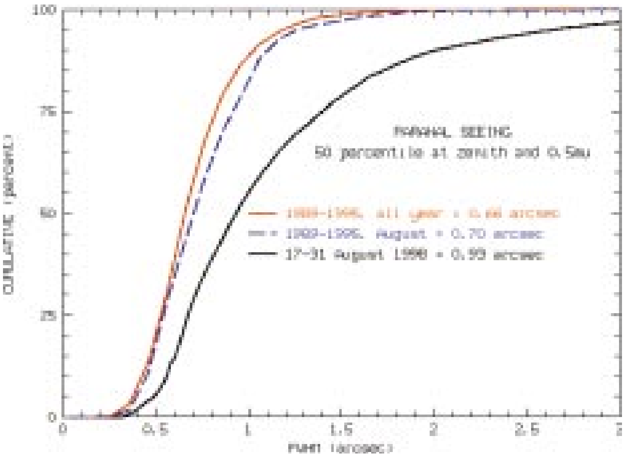
When this occurs during the science verification of the first 8-m-class telescope mounting a monolithic mirror, the event deserves a more detailed analysis.

*Cloudiness at Paranal is the conjunction of seasonal trends and El Niño events on top of some longer, as yet unexplained cycle (*The Messenger *90, 6). As we are currently in the lows of the latter cycle and despite the end of the 1997–98 El Niño event, August 1998 was promising less than 70% photometric nights: the two nights lost for cloudiness during the two weeks of science verification were thus well within expectations.*

The wind at Paranal is stronger in winter (30% of the time more than 10 m/s) than in spring or summer (15% only): one and a half nights lost because of wind in two weeks of observing is thus not anomalous.

As clouds have no reason to prefer windy nights, the two previous effects tend to cumulate and the total time lost was close to 30% of the total available observing time, nothing to be ashamed about!

Unfortunately, the seeing conditions were not at all inside the statistical margin as can be seen on the figure: not only did we have an excess of very bad seeing (10% of the time worse than 2 arcsec) but also a deficit of good seeing periods (3 times less than normal).

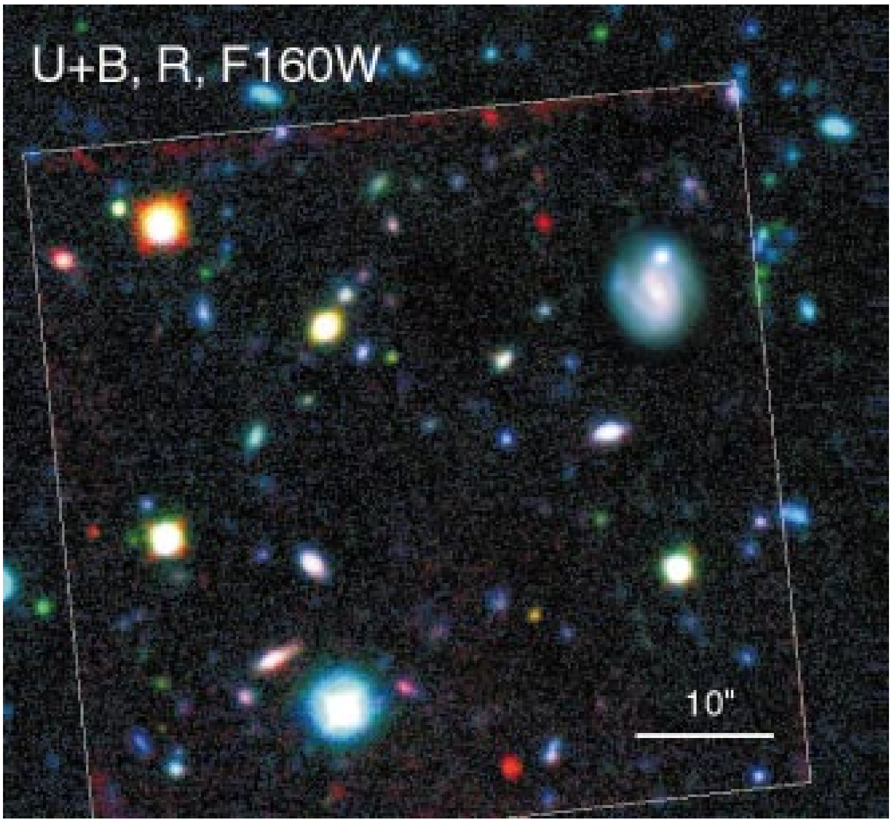


This situation cannot be explained by a synoptic analysis: only a slight excess of temperature was reported over South-America during the first week, the jet stream behaviour was also quite normal during the whole period. Nevertheless, the wind vane at Paranal more than usual kept pointing at north-east or south-east where the bad seeing comes from (valleys and nearby summits). In addition, a cold front causing a sudden drop of the air temperature turned the ground around the observatory into a highly efficient local seeing generator several degrees warmer than normal.

Whatever further improvements we make in the understanding of the generation mechanism of atmospheric turbulence, the operation strategy of ground-based astronomical facilities has nevertheless to be designed to confront from time to time a highly non-deterministic environment.

M. Sarazin

Figure 2: The colour composite of the HDF-S NICMOS field constructed by combining the VLT test camera images in U + B and R with the near-IR HST NICMOS/camera 3 F160W (~ H band) 7040 s exposure. These images were used for the blue, green and red channels, respectively. The NICMOS image was smoothed to match the resolution of the R-band VLT image. The boundary of the NICMOS image is also shown.



The measured image quality on the test camera frames has been often better than the outside seeing as measured by the DIMM seeing monitor. At least part of this effect is due to the field stabilisation operated by the secondary mirror, which worked in closed loop all through the SV period. Also the M1 active control worked in closed loop through all the observations. In practice, the figure of the primary mirror is optimised several times per minute with no operational overhead. The seeing/image quality data are now being analysed to gather a better understanding of the telescope performance and of the site seeing while extreme meteorological conditions were prevailing.

On the morning of September 1, the telescope was returned to the Commissioning Team, and commissioning resumed.

Figure 1 on the front page is a colour composite of the HDF-S NICMOS field that combines *U*, *B*, *R* and *I* frames with image quality better than 0.9″, as listed in Table 2.

Figure 2 shows the colour composite of the same field with the addition of the H-band HST/NICMOS (F160W) image from the ST-ECF public archive reduced at ST-ECF by W. Freudling. The HST image (Figure 3) was obtained with nearly the same total exposure time as the VLT (R-band) images, and their combination is meaningful since the VLT and NICMOS images reach similar depths. This is the result of several effects compensating each other, such as the K-correction, the better angular resolution of the HST image (~ 0.2″), and the larger collecting area of the VLT.

All objects in the NICMOS image are also noticeable in Figure 1, with the exception of the very red object in the vicinity of the face-on spiral. The bright red object near the bottom of the image was noted by Treu et al. (astro-ph/9808282) as being undetected on optical images to the limit of R = 25.9. This object is clearly present in all the VLT test camera coadded images, with the exception of the U-band image.

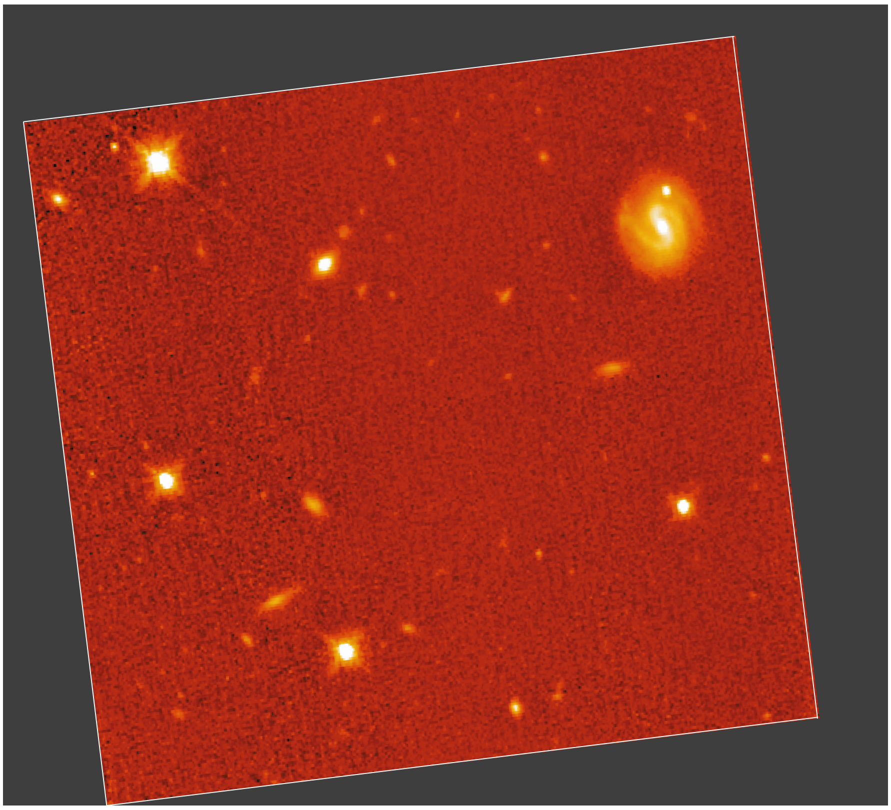


Figure 3: The original, undegraded HDF-S NICMOS image of the same field shown in Figure 2.

Figure 4 shows the colour composite image of the optical Einstein ring 0047-2808 (Warren et al. 1996, MNRAS, 278, 139), a $z = 3.595$ star-forming galaxy which is lensed by a red elliptical at $z = 0.485$. Exposure times are 1 h in the narrow-band filter NB559 (centred at the redshifted Lyα of the distant galaxy) and 900 s in *B* and *V*.

Bruno Leibundgut and Roberto Gilmozzi of the SV Team conducted the observations on Paranal, with the local assistance of Martin Cullum of the SV Team and of Eline Tolstoy and Marc Ferrari (both ESO fellows). Jason Spyromilio, Anders Wallander, Marco Chiesa and Stephan Sandrock of the VLT Commissioning Team ensured smooth telescope operations throughout the whole period. The Paranal Engineering Department under Peter Gray provided all the main-

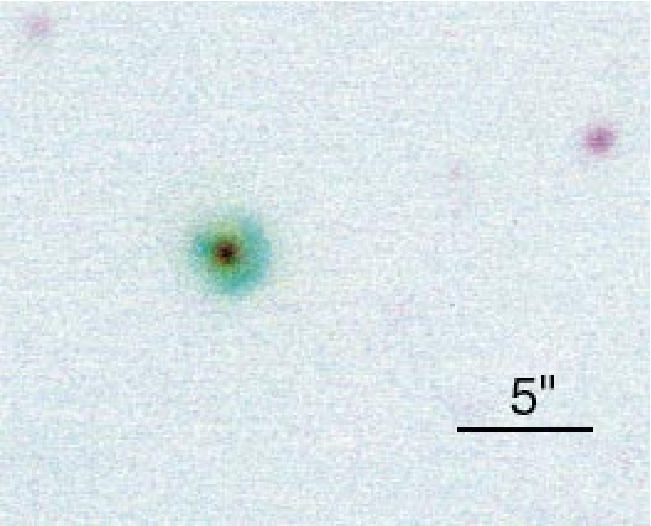


Figure 4: The colour composite image of the optical Einstein ring 0047-2808, produced by a red elliptical at z = 0.485 lensing a star-forming galaxy at z = 3.595. A 1-hour image through a narrow-band filter centred at the redshifted Lyα of the distant galaxy is coded green, while the 900-s B- and V-band images are coded blue and dark red, respectively. The lensing galaxy appears dark red at the centre of the ring.

tenance and trouble shooting support that was needed.

The rest of the SV Team, including Guido De Marchi, Francesco Paresce, Benoît Pirenne, Peter Quinn, Alvio Renzini, and Piero Rosati guaranteed quick reductions and quality control of the data in Garching and prompt feedback to the Team on Paranal. Fabio Bresolin and Rodolfo Viezzer of the Office for Science extensively contributed to the reductions and calibrations. Robert Fosbury and Richard Hook of the ST-ECF combined the coadded frames to produce the colour images presented here.

Results, problems, and strategy were discussed in daily video-conferences Garching-Paranal, that were also attended by Massimo Tarenghi, the Director of the Paranal Observatory. The video-conferences took place at about noon Garching time (6 a.m. on Paranal), with the Paranal team reporting on the observing conditions and the observations completed during the night, and the Garching Team reporting on the progress in inspecting and reducing the data of the previous nights. Then, while the Paranal people were sleeping, data from the previous night were inspected and reduced in Garching, with feedback on what was best to do during the following night being emailed to Paranal several hours in advance of the beginning of the observations. The SV Team was really active 24 hours a day.

The First Steps of UT1

M. TARENGHI, P. GRAY, J. SPYROMILIO AND R. GILMOZZI

Introduction

The Very Large Telescope is the result of 20 years' work by a large team of dedicated persons. We thank them all for their contribution. During the last few months we had the privilege to witness exciting moments. The following notes will enable the reader to share in those moments.

The Final Steps Up to First Light

During January and February 1998 the mechanical structure of the telescope underwent a series of tests and tune-ups. These activities were undertaken with the dummy cell and dummy secondary units installed. A small 8-inch Celestron telescope was attached to the telescope centrepiece, and a VLT technical CCD was put at its focus. The guide scope had first light in March. A rough pointing solution using 8 stars was derived for the telescope, which gave an rms pointing error of 8 arcseconds. The basic pre-setting and tracking of the telescope were also tested. Using a VLT TCCD for the guide scope also allowed us to test the basic functionality of the autoguiding system.

The code running on UT1 is almost identical to that running on the NTT, and very few code integration problems have arisen. The year spent on the NTT certainly has meant time saved on UT1. In Garching an additional control system, including TCCDs, routers and other peripherals, was also up and running. This allowed our colleagues at Headquarters to reproduce problems we were having on the mountain and provide quick fixes whenever possible.

Meanwhile in the base camp at Paranal, a complete duplicate telescope control system was established with identical configurations to the one running the telescope. The workstations and local control units in the base camp even shared networking addresses with the machines on the mountain top. One side effect was that, given this configuration, only one set of these computers could actually be connected to the Paranal network. The base camp control system was therefore completely stand-alone. To

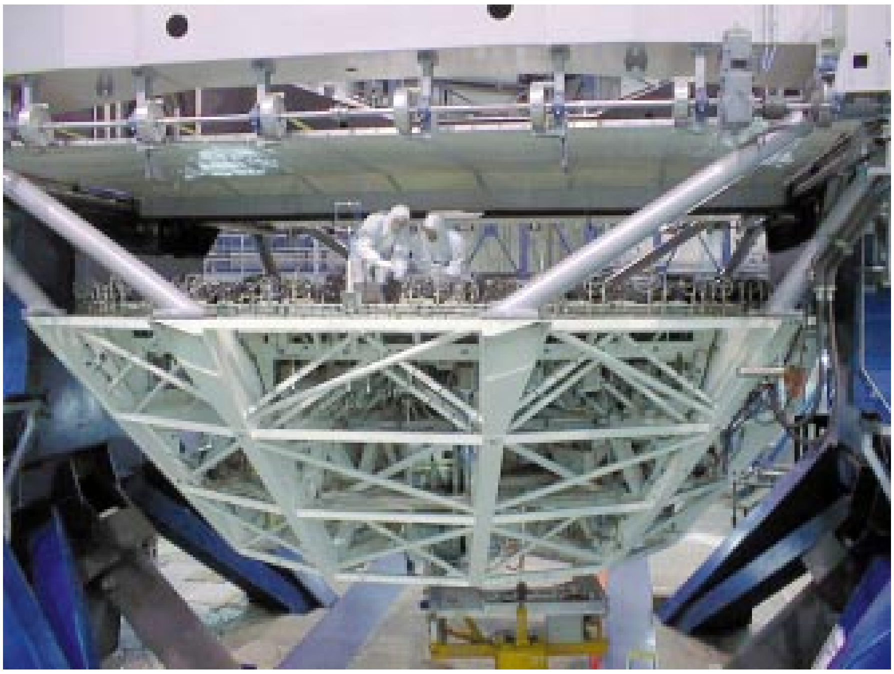


Figure 1: The start of the night.

transfer files between systems, necessary to keep the two systems aligned, a new class of network was used, known affectionately on the mountain as "footnet".

One problem found during the tests in March was that the telescope oscillated in altitude by a few arcseconds. Extensive checks on the oil system by Juan Osorio and others did not reveal the cause. The problem was tracked down to the velocity controller that caused Martin Ravensbergen and Toomas Erm some headaches. However, they found the bug and following the fix they brought the behaviour of the telescope tracking down to excellent values. Without any wind-loading the telescope tracks with accuracies of 0.05 arcseconds rms for extended periods of time. However, when we pointed the telescope into the wind, the wind shake was clearly noticeable. This was expected to be the case from detailed simulations done during the design phase. The mechanism for compensating for wind shake is field stabilisation i.e. rapid motion of the secondary mirror equivalent to tip/tilt corrections. In the planning this was not foreseen to be implemented before August.

The priorities were changed. Gianlucca Chiozzi and Robert Karban went back to Garching and worked furiously on the control model to accelerate the implementation.

The secondary unit of the telescope and primary mirror cell were installed in the telescope in March. Valiant efforts by Max Kraus, who spent a good fraction of his time trying to convince everyone that an air-compressor was just like a tractor and he could fix it, which he did, together with Erich Bugueno and German Ehrenfeld along with a cast of ADS workers managed to fit the cell on to the telescope. The concrete dummy mirror was the location of many a conference on how the cell should be attached to the telescope for the first time. The behaviour of the telescope with a configuration very close to the one expected when the real glass went in could then be tested. Changes in the servo loop parameters and other such niceties, which are critical for the correct and safe behaviour of the telescope, were made.

The primary mirror cell was undergoing qualification tests now that we could move it around and tip it over. Inclination tests had been done in France prior to delivery to Paranal but now we had a real chance to move the thing around. It was hard to get Stefano Stanghellini, Gerhard Hudepohl or Marc Sbaihi out from inside the cell. We knew theoretically that pushing the emergency stop on the telescope under full speed would not activate the earthquake detector on the cell. Would it in practice? Would the airbag system inflate automatically when the cell tipped over 75 degrees? How far did the mirror move in the cell when inclined?

Figure 2: The team on the night of April 25.

The test camera had now been installed on the telescope. Martin Cullum and Ricardo Schmutzer were testing the software to make sure that when we needed to open the shutter, the instrument would actually take a good image. Flat fields and bias frames were taken constantly.

It was time to coat the mirrors before putting them into the telescope. Both the primary and the secondary mirrors had been on the mountain for a while sitting in their boxes waiting for their turn. So the coating chamber was fired up for a final check and ... we had a failure in the system which damaged the aluminium target used for the sputtering. Our colleagues in Linde, the prime contractor for the coating unit, were despondent. Not only had the unit failed at a critical time but they would also have to come all the way back to Paranal to repair it. A quick recovery plan was needed. Michael Schneermann went off to find another target (a non-trivial task since these are custom-made out of the purest aluminium) and Linde tried to find out what had gone wrong.

We now had to find a way to proceed without endangering the timeline for the telescope nor of course any of the optics. The secondary mirror went to La Silla, under the watchful eyes of Paul Giordano. Paul travelled with it along the 70 km of dirt road linking Paranal to the Pan-Americana highway at the excruciatingly slow speed of 5 km/h and then the other 700 km down to La Silla. Paul coated the secondary mirror at the 1.5-m tank and returned to Paranal. The quality of the coating and the mirror were excellent with reflectivities above 90 per cent and micro-roughness around 10 Angstroms. The mirror was then put into the unit, which, as mentioned above, was already installed in the telescope.

The primary was not so simple. We decided that we should install the uncoated mirror in the telescope and go ahead with the final preparations towards first light. Our integration plan, released back in 1996, for the first-light specification, allowed us to have an uncoated mirror at first light. In order not to delay the availability of the VLT to the community in April 1999, we decided (in agreement with the Director General) to proceed with first light as planned. So, in the third week of April, the cell went on its way down to the base camp, had the dummy mirror removed and the 8.2-m zerodur thin meniscus installed. On the night of the 21st of April, the telescope was almost all in place. Both the primary and the secondary mirrors were in place. We had already planned for a small celebration when these events had taken place. In the base camp, ESO and SOIMI had a party. For some of us it had to be cut short. We decided that on the same night we would try the telescope optics out. Before doing so, the protective plastic over the primary, which was placed on the mirror to protect it during transport from Europe to Paranal, had to be removed. Francis Franza and Paul Giordano put on their clean-room clothing, climbed on the mirror and started peeling the plastic off. We had thought the operation would take an hour or so but ended up taking three hours. Now we had a real telescope. The primary mirror looked truly beautiful. A couple of tests with the enclosure closed to ensure everything was O.K. and the big moment arrived. The enclosure doors were opened, the mirror cover retracted, and we pointed the telescope at a globular cluster. Zero forces were set on the primary and then the telescope was refocused manually. In a moment of great relief, the "first star" appeared on the guide probe. In retrospect, looking at that image, it is obvious that we had left the reference light arm (without the light on) in the beam, which explains the shadow one can see on that image. The star was about 2 arcseconds in size. Lothar Noethe quickly let us all know that this was exactly according to the specification for the zero forces configuration of the primary. Some of us had expected the star to just drift away, others that it would look nothing like a star. In fact, the telescope did us proud. Immediately the Director General was informed.

Now the task of running the telescope at night passed to the commissioning team although officially we had not had first light. Active optics tuning was the main task. Lothar Noethe, Stephane Guisard and Roberto Abuter started mapping the aberrations of the telescope, their orientation and their dependence on zenith distance. After a couple of nights of looking at 2 arcsecond stars and from time to time at stars that looked like pieces of string or propellers (when Lothar induced aberrations to check the behaviour of the cell), the time came to close the loop. The DIMM was not running that night, so we do not know what was the outside seeing. When the loop closed, the star became really small. We started taking short exposures with the guide probe and measuring the FWHM. The active optics was working away continuously correcting the mirror shape and the position of the secondary mirror. The first images were 0.8 arcseconds in size. Great jubilation in the little wooden hut inside the enclosure where all of the control was taking place. Stephane Guisard was placing bets as to whether we would beat the 3.6-m record. A few minutes later as the active optics worked, the images went down to 0.4 arcseconds. Only 3 nights after the optics had gone in, the telescope was already matching our highest expectations.

Pointing solutions and field stabilisation tests were started in order to improve the performance of the telescope. Pointing quickly came down to around the 3-arcsecond rms level. Field stabilisation baffled us all for a while. The nature of various time delays and the synchronisation of the TCCD with the secondary unit kept people busy for a while. Antonio Longinotti, our CCD software expert, made a couple of configuration changes and now we could move the M2 unit at frequencies up to 20 Hz.

Although first light was specified for the night of the 25th of May, the internal planning target date was the 15th of May. By this time we had moved out of the hut in the enclosure and were operating the telescope from the relative comfort of the control room. On the night of the 15th of May we decided that we should meet all specifications laid out in the integration plan for the telescope. The target was to be ω Cen. Conditions were excellent: low wind and good seeing. We started a 10-minute exposure on target with the test camera. We had never tried anything as long as this. Krister Wirenstrand anxiously waited for the test camera CCD to read out. This was to be the first true image taken with the telescope on a scientific CCD. When the image was transferred to the Real Time Display, we quickly measured the image quality. Great jubilation again as the stars appeared at 0.48 arcseconds. A series of other measurements on tracking stability and image quality verified the telescope had met all the performance criteria for first light.

By now, the new aluminium target had arrived on the mountain and had been integrated into the coating unit. Performance verification of the coating unit by Linde was under way. On the 18th of May the coating unit was ready. At 4 a.m. the telescope was stopped and parked in the mirror removal configuration. Martin Cullum and Francis Franza started taking the test camera off and by midday the mirror cell was off the telescope.

That night the cell and mirror were in the base camp. The mirror was detached from the cell overnight and the following day lifted out of the cell and into the coating unit. Our washing unit is not yet on the mountain. However, visual inspection of the mirror showed only light dust had settled during the 4 weeks the mirror had been in the telescope. Paul Giordano and Francis Franza started the long and laborious cleaning of the mirror using carbon dioxide snow. This worked very well, especially at the edge of the mirror. The mirror was now as clean as we could get it. The coating unit was sealed, evacuated and then the mirror was coated. The time had come to see what it would look like. We were concerned that since some dust had been left on the mirror, the coating might fail. We were glad to be proven wrong. Although better coatings will come, the first was already good. The reflectivity was above 90 per cent around the edges of the mirror and dropped to 89 per cent in areas where the CO_2 cleaning had not worked so well.

The mirror was put back into the cell and driven up to the telescope the following morning. Two nights and three days after it was removed, the completed operation returned the telescope back for further tests before first light. Would the

Figure 3: The first star.

Figure 4: Informing the DG.

Portuguese Minister of Science at Paranal

On Sunday, July 19, 1998, ESO was honoured to receive a visit by the Portuguese Minister of Science and Technology, Professor Mariano Gago, to the Paranal Observatory. The Minister was accompanied by the Ambassador of Portugal to the Republic of Chile, Mr. Rui Félix-Alves and a delegation.

The Minister visited the various VLT installations and, a scientist himself, expressed great interest in this new facility, now being constructed by the European Southern Observatory on behalf of the ESO member states. As foreseen in the 1990 Agreement that associates Portugal and ESO, discussions about future Portuguese membership in ESO have started.

The Portuguese Minister of Science and Technology, Professor J.M. Gago, with the VLT Project Manager and Director of the Paranal Observatory, Professor Massimo Tarenghi (right), ESO astronomer Dr. Jason Spyromilio (left) and members of the delegation in the VLT Control Room.

pointing solution have changed? Would the alignment and active optics calibration need to be repeated? The pointing indeed had changed. The stars appeared a full 2 arcseconds away from where they were before the entire operation took place. Such a small change encouraged us that the active optics would not need re-calibration. Indeed there seemed to be no need. The telescope was delivering 0.4 arcsecond images yet again.

Now all we had to do was wait for the 25th of May and keep our rendezvous with the press. Of course we could not resist and took images on the nights leading up to the first-light night. Julio Navarrete was on hand in the ASM hut running the DIMM and the meteorological station and answering the constant call on the radio: “Julio, can we have seeing please?” The night of the 24th was beautiful. Things had been going too well. At the beginning of the night the earthquake detector on the mirror cell went off. Stefano Stanghellini and Marc Sbaihi worked to release the mirror from the safety clamps and a few hours later the telescope was available again. Then at the end of the night when closing the telescope down, a major problem occurred. The mirror cover jammed half way across the mirror. Could it be repaired in time for the night of the 25th? Marc Sbaihi and the ADS crew came to the rescue. Working just above the mirror from early in the morning until after sunset, they managed carefully to open the cover and provide the beam to the telescope. The final hurdle had been overcome. The telescope was operational again. All this effort – and then the weather worked against us. The first half of the night things went well and some images were taken. Krister Wirenstrand operated the telescope while Anders Wallander made sure the test camera took the images. However, in the second half following our little internal celebration, the weather was poor and we shut the telescope down.

Commissioning of UT1

The commissioning of UT1 officially started immediately after first light. Most activities in commissioning involve tuning of telescope parameters and understanding how UT1 should be used. A number of software modifications are being made based on this better understanding that we have developed.

It took us far too long but eventually we realised that we had been focusing the telescope in the wrong way. We worked it out and on the 1st of June a new procedure was used. Since then the telescope has been in autofocus mode. We have made the guide probe parfocal with the instrument and have let active optics handle the telescope focus. In this mode the telescope focus is maintained continuously throughout an exposure as the active optics runs.

Improvements in the field stabilisation have been taking place. Birger Gustafsson has been reducing the delays in the M2 and Philippe Duhoux improved the centroiding algorithm in the CCD software. These changes improve the performance of the telescope under heavy wind load.

A lot of small changes here and there improved the reliability of the system and the operability of the telescope. Marco Chiesa worked on the control algorithm for the enclosure rotation and parking which has made the operation much smoother and faster. Thanh Phan Duc improved the guide-star acquisition procedure significantly.

Marc Sarazin, Stefan Sandrock and Rodrigo Amestica have brought the ASM to fully automatic status. Commissioning UT1 includes working with a cm-class telescope and understanding its problems as well. We are learning what it is to have a fully automatic telescope running.

Paranal is truly a beautiful site. The winter has given us quite a number of nights with poor conditions, sometimes it is cloudy and occasionally the seeing does go above 1 arcsecond. However, the beautiful nights are truly spectacular. On the night of the 26th of June, Anders Wallander and Ivan Muñoz took a series of 30-second exposures with an image quality below 0.35 arcseconds including one at 0.27 arcseconds.

The control and quality of the optics is excellent. Long exposures (900 and 1800 seconds) are taken as a matter of course to check the performance of the telescope under realistic observing conditions. The telescope routinely matches the outside. The active optics is run in continuous closed loop.

FORS, the first instrument to go on to the telescope in September, is already being re-integrated on the mountain, and ISAAC, which goes onto the telescope in November, is already integrated in the Control building.

A first commissioning/installation of the data-flow software was undertaken by Peter Quinn, Michèle Péron and Miguel Albrecht in June. All data from UT1 are now being archived immediately after they are taken. This includes the extensive operations logs that record all actions of the system. For example, all aberrations calculated in every active optics calculation are logged. All temperatures of the telescope, and there are many, are also logged. Every preset, offset, change in guide star and many other actions are logged. All telescope errors or unforeseen events are also logged. We use this information to better understand the telescope and how it can be optimised.

A lot of work remains to be done. The tertiary mirror will go into the telescope in August and the Nasmyth foci can then see light for the first time. The Linear Atmospheric Dispersion Compensator for the Cassegrain focus also goes into the telescope in August. Commissioning of the Nasmyth foci will take place between instrument installations. A better understanding of the dome louvers and how they affect the telescope performance is high on our priority list.

Science verification of the telescope is scheduled for the dark run in August, and we fully expect some beautiful data to result from these two weeks.

The cast of people working towards a successful VLT is too great to mention explicitly in such an article. The administrative support both in Garching, Santiago and Paranal that somehow managed to get all the pieces onto the mountain in time are thanked. Isabel Osorio was ever present and helping with pretty much everything. We also thank La Silla for providing us with coating facilities. Special thanks are due to Armin Silber, Enzo Brunetto, Mario Kiekebusch, Olaf Iwert and Claudio Cumani who all worked to get the test camera going; Marco Quattri who spent most of the northern winter on the mountain monitoring the erection of the telescope; Mathias Hess who worked tirelessly on the M1 cell and the transport of the mirror and then missed first light by a few weeks; Jean-Michel Moresmau who managed to fit the Cassegrain adapter into the cell and hook up all those little cables and wires; Manfred Ziebell who never stopped worrying about everything and anything and Michel Duchateau who worried about all the little details like emergency stop buttons; Jörg Eschwey and the facilities department on Paranal who built most of the things around us and who also switched all the lights off in the base camp; Canio Dichirico who made sure we had power when we needed it; Bruno Gilli, Gianni Raffi, Giorgio Filippi and others in the software group who kept us on the true path. Of course, we thank the entire VLT division in Garching for designing and building such an excellent telescope; our system and network administrators on the mountain, Chris Morrison, Nick Lock, Marcelo Carrasco, Sebastian Lillo, Graeme Ross, Mark Tadross and the ever present Harry Reay who made sure all systems were ready. We apologise to all that we have missed in our thanks.

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The Cost of the VLT

Text of a Report of the ESO Director General to Council at its (extraordinary) meeting of September 15, 1998

The purpose of this document is to provide an overview of the VLT cost evolution since 1987, and an estimate as of to-date of the total cost of this project at ESO until the completion of the VLT/VLTI in 2003. The total cost we quote includes the external contractual costs, the internal labour and other costs directly VLT-related, the development of the Paranal Observatory and its operations until 2003. This is the date that will see the completion of all 8-metre telescopes, the auxiliary telescopes and all approved instrumentation. It does not include the manpower costs at member state institutes contributing to the instrumentation programme.

The information compiled here is extracted from documents already submitted to Council. However it appears useful after the successful completion of first light, which removes any major technical uncertainties, to present a summary giving Council a global perspective on the project.

1. The VLT Contractual Cost

The VLT Programme was approved in 1987 on the basis of a proposal known as the “Blue Book”, which gave a cost estimate of 524 MDM (1998 prices) for the external contracts, including 34.8 MDM (1998 prices) for VLTI.

Since then the scope of the VLT Programme has evolved considerably to include some major new features and more complex solutions. These include the introduction of a Cassegrain focus and adapters with their subsequent impact on the M1 Cell and Main Structure, sophisticated test cameras, a time reference system, astronomical site monitors, etc.

In 1993 a complete Cost to Completion analysis was performed (Cou-483 and Add.) and subject to an external audit in 1994. Council subsequently approved a VLT Programme for 592 MDM (1998 prices) in which the Interferometry part had been postponed and its funding reduced to 7 MDM (Cou-516 conf.).

ESO worked out a recovery plan for the VLTI, which was presented to Council in 1996. The cost of this new plan (32 MDM in 1998 prices) was financed by reprogramming within the VLT and Instrumentation programme, by an additional contribution of 10 MDM by MPI and CNRS and through release of contingency funds.

Thus in the period 1994 to 1998 we have not changed the VLT programme cost to member states while fully restoring the VLTI programme.

The current VLT cost ceiling of 602 MDM for external contracts appears quite firm since we are at a point in the programme where we have committed 87% of the contractual cost. The increase of 15% with respect to the Blue Book Value of 1987 is fully justified by the substantial changes in scope of the project mentioned above.

2. Total Cost of the VLT Programme

The Blue Book did not provide an estimate of the total cost (including ESO staff and other internal costs). An evaluation of the VLT-related internal costs, i.e. engineering costs in Garching and site costs at Paranal, was performed in 1993 and also subject to the 1994 external audit.

In 1996 ESO submitted to Council a long-range plan to bring the Organisation to the steady state of operations of the full VLT/VLTI (1996–2003) while implementing strict cost containment measures to meet a reduction in the projected mem-

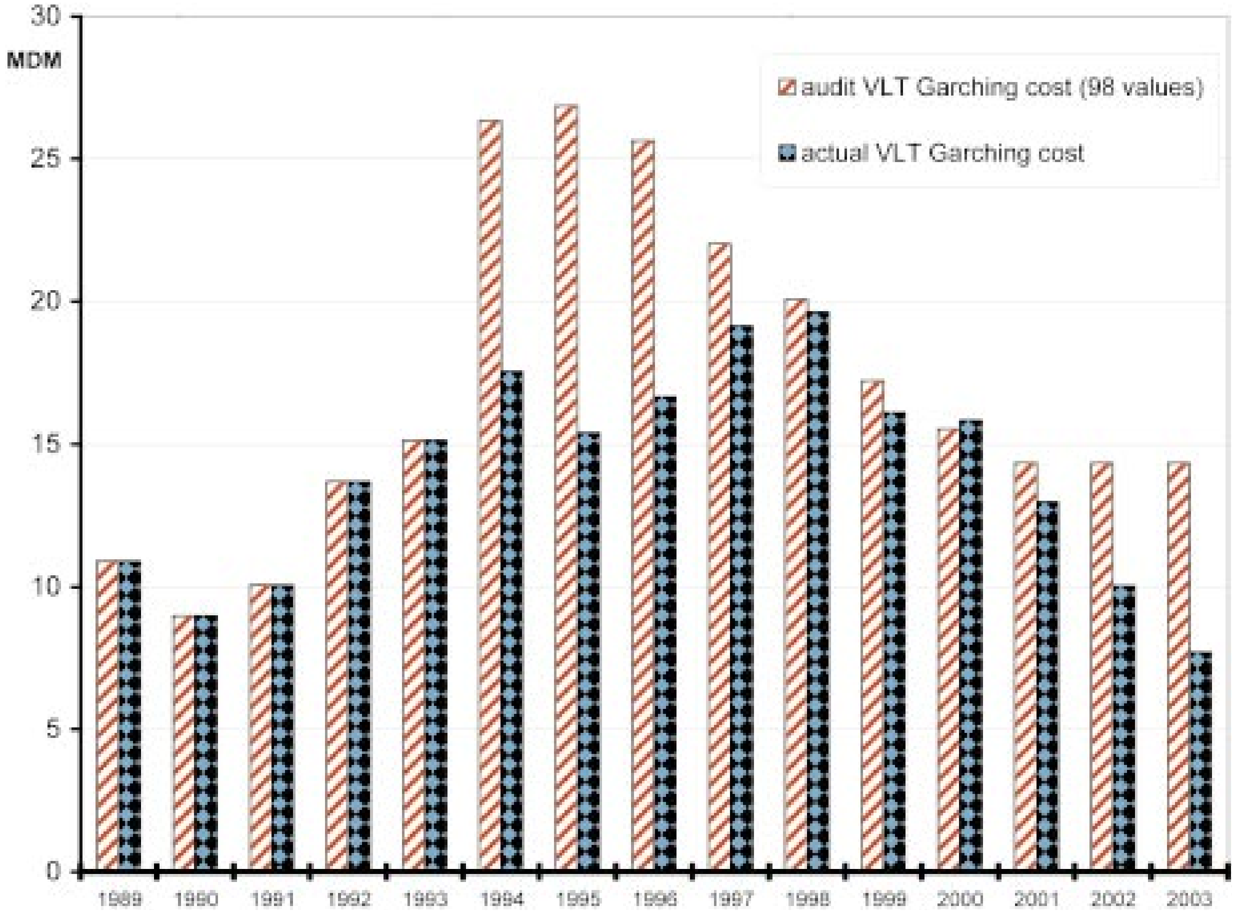


Figure 1: VLT Garching cost (yearly) (ESO internal staff, operations and investments).

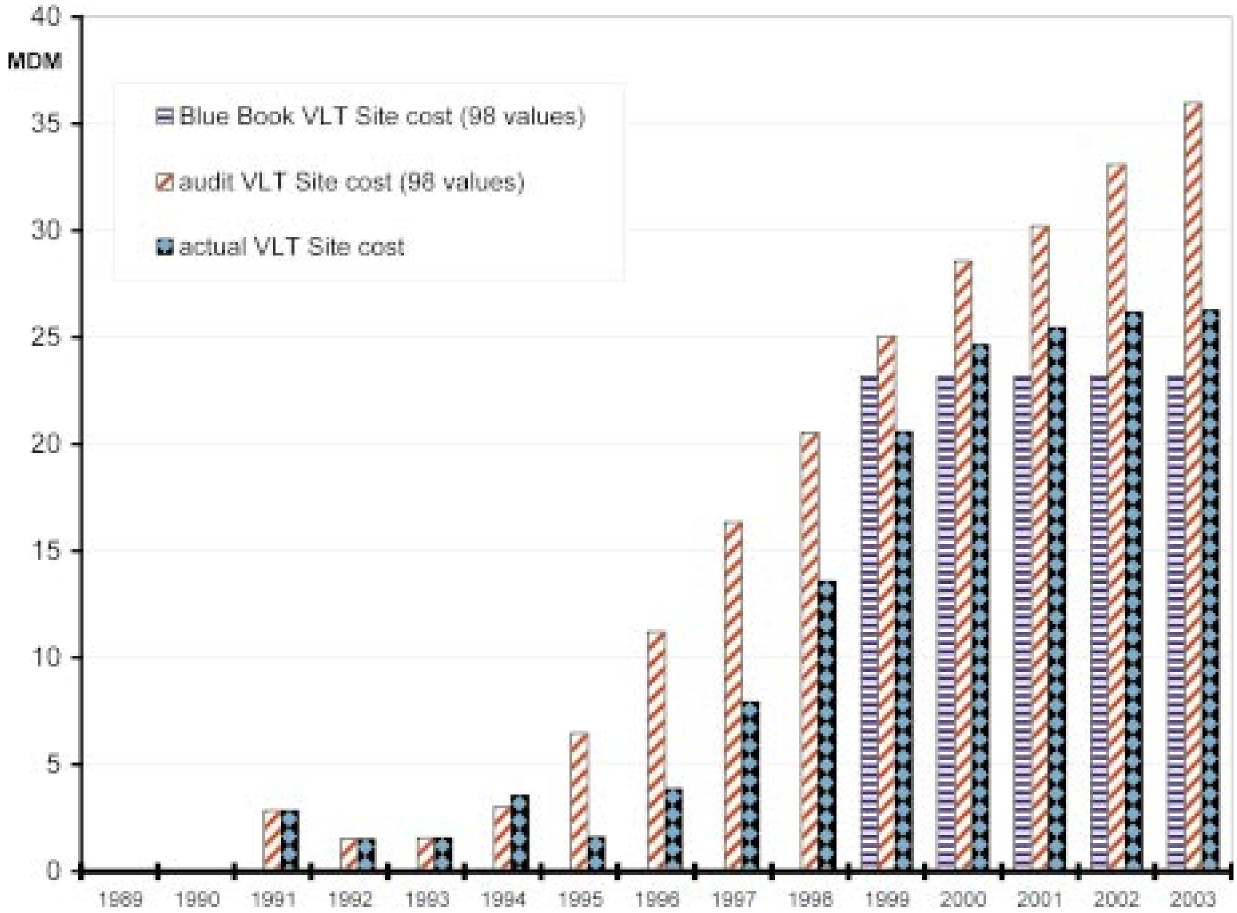
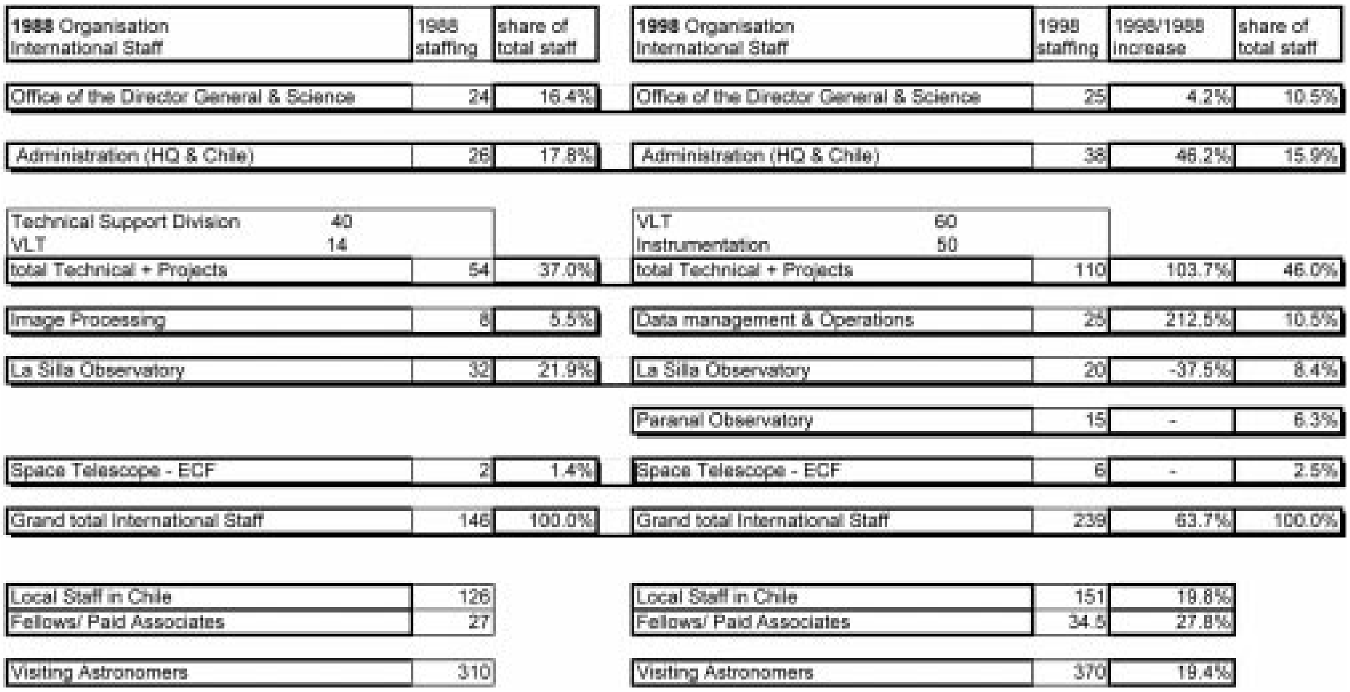


Figure 2: VLT site cost (yearly) (ESO internal staff, operations and investments).



1988 Organisation International Staff	1988 staffing	share of total staff	1998 Organisation International Staff	1998 staffing	1998/1988 increase	share of total staff
Office of the Director General & Science	24	16.4%	Office of the Director General & Science	25	4.2%	10.5%
Administration (HQ & Chile)	26	17.8%	Administration (HQ & Chile)	38	46.2%	15.9%
Technical Support Division 40			VLT 60			
VLT 14			Instrumentation 50			
total Technical + Projects	54	37.0%	total Technical + Projects	110	103.7%	46.0%
Image Processing	8	5.5%	Data management & Operations	25	212.5%	10.5%
La Silla Observatory	32	21.9%	La Silla Observatory	20	-37.5%	8.4%
			Paranal Observatory	15	-	6.3%
Space Telescope - ECF	2	1.4%	Space Telescope - ECF	6	-	2.5%
Grand total International Staff	146	100.0%	Grand total International Staff	239	63.7%	100.0%
Local Staff in Chile	126		Local Staff in Chile	151	19.8%	
Fellows/ Paid Associates	27		Fellows/ Paid Associates	34.5	27.8%	
Visiting Astronomers	310		Visiting Astronomers	370	19.4%	

Figure 3: Evolution of ESO staffing between 1988 and 1998.

ber states contributions and still restore the VLTI programme. Reductions in cost and delays in spending were also necessary to reduce the anticipated negative cash flow projections.

As a result, the actual internal cost of the VLT engineering in Garching between 1993 and 1998, and the projected estimates up to 2003 are in fact substantially lower than the 1993 estimate (Fig. 1).

The evolution of the Paranal site cost also shows a decrease (Fig. 2). Preliminary VLT operation cost after 1999 was indicated in the Blue Book. This is also given in Figure 2 for comparison.

The VLT total cumulative cost to completion (including the initial operations of the Paranal Observatory) is estimated to reach 990 MDM (1998 prices) in 2003. Thus while the contract costs increased from 592 MDM to 602 MDM (due to the additional contributions of 10 MDM for VLTI), the total VLT/VLTI costs at completion decreased from the 1994 estimate of 1060 MDM to 990 MDM (1998 values).[1]

3. ESO Overheads

The ESO organisation has substantially grown and evolved since 1988 to cope with a programme whose value in external contracts is 8 fold its 1987 annual budget (total cost 13 times the 1987 budget) (Fig. 3).

In 1988, the ESO staff complement was composed of 146 International Staff positions (ISM), 126 Local Staff in Chile (LSM), 27 Fellows and Paid associates (Fel/PA). In 1998 the staff complement includes 239 ISM (+64%), 151 LSM (+20%) and 34.5 Fel/Pa (+28%).

In 1988, 50 ISM (34% of the total ISM) worked for the Office of the Director General, Science Office and Administration. There are 63 ISM (26% of the total ISM) working in these areas in 1998. In these 10 years we have therefore decreased the fraction of the staff not directly engaged in programmatic activities.

The rest of the staff works directly for the core activities of ESO: VLT, Instrumentation, Paranal Observatory, Data Management and Operations, La Silla Observatory, and ST-ECF (Fig. 3). During the same period and even prior to the initiation of the VLT programme the number of astronomers using the ESO facilities (visiting astronomers) has increased by 20%. We expect this number to more than double when the VLT initiates science operations (April 1, 1999).

The comparatively low increase of the management and administrative resources is a very clear indication that the overhead cost of ESO in general has decreased compared to the era before VLT. (More detailed comparisons are difficult due to the accounting tools available in 1988).

4. Conclusion

In conclusion, the VLT contract cost ceiling has increased 15% in comparison to the Blue Book (1987), an increase which is fully justified by the technical evolution of the Programme scope. The cost which now includes a fully restored VLTI Programme has remained unchanged compared to the approved Cost to Completion of 1994. A comparison of the cumulative VLT total cost (including VLT contract cost, personnel cost, operations, site development and investments) at the time in 2003 when VLT will be in full operational phase shows a decrease from 1060 MDM to 990 MDM with respect to the estimates audited in 1994.

These results were obtained in spite of the contractual and overall cost increases due to the delays experienced in Chile as a result of the Paranal ownership issues.

At the same time, the Organisation has improved its efficiency by containing the growth of the administrative staff and reducing its proportion of the total.

Cost and technical performance at the level achieved on the VLT programme is rare among major scientific/technical enterprises and could not have been achieved without the professionalism, competence and dedication of the ESO staff.

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[1] Please note that all figures have been entirely updated to 1998 prices to provide for a coherent comparison, including the expenditure actually occurred in the past years, which accounting value would normally not be updated. The current "mixed" value of the VLT contracts is 574 MDM while the current "mixed" value of the VLT total cost estimate is 944 MDM.

ESO and AMOS Signed Contract for the VLTI Auxiliary Telescopes

B. KOEHLER, ESO

The company AMOS (Liège, Belgium) has been awarded, last June, an ESO contract for the delivery of the Auxiliary Telescopes (ATs) of the Very Large Telescope Interferometer (VLTI). Each of these telescopes has a main mirror of 1.8-metre diameter. They move on rail tracks on the top of the Paranal mountain. Together with the main 8.2-m VLT Unit Telescopes (UTs), they will ensure that the VLTI will have unequalled sensitivity and image sharpness that will allow front-line astronomical observations.

This contract was signed for the design, manufacturing and testing in Europe of two ATs and of the full set of on-site equipment for the 30 AT observing stations. An option for a third Auxiliary Telescope is also part of the contract. The delivery in Europe of the first AT is planned for June 2001 and the first observations with the first two ATs at Paranal are planned for early 2002.

More details can be found at: http://www.eso.org/outreach/press-rel/pr-1998/phot-25-98.html

The photo of a 1/20 scale model built by AMOS in response to the call for tender illustrates the main conceptual features of the VLTI Auxiliary Telescopes. The 1.8-m telescope (with an Alt-Az mount, i.e. exactly like the Unit Telescopes) is shown here in observing conditions. It is rigidly anchored to the ground by means of a special interface. The light is directed via a series of mirrors to the bottom of the telescope from where it is sent on to the underground delay line tunnel. The AT Enclosure consists of segments and is here fully open. During observation, it protects the lower part of the telescope structure from strong winds. The Enclosure is supported by the transporter (the blue square structure) that also houses electronic cabinets and service modules (the grey boxes) for liquid cooling, air conditioning (the red pipes), auxiliary power, compressed air, etc., making the telescope fully autonomous. When the telescope needs to be relocated on another observing station, the transporter performs all the necessary actions such as lifting the telescope, closing the station lid (the white octagon), translating the telescope along the rails, etc. The complete relocation process will take less than 3 hours and shall not require re-alignment other than those performed remotely from the control room at the beginning of the next observation.

UT1 Passes “With Honour” the First Severe Stability Tests for VLTI

B. KOEHLER, F. KOCH, ESO-Garching

1. Introduction

Over the past years, a significant effort has been put in verifying and improving the capability of the VLT Unit Telescope (UT) to reach the very demanding Optical Path Length (OPL) stability at the nanometer level, as required by the VLT Interferometer (VLTI). Up to now, this has been done primarily by analysis using detailed Finite Element Models with inputs from dedicated measurement campaigns such as the characterisation of micro-seismic activity at Paranal [1], [2], vibration tests on IR instruments closed-cycle coolers and pumps [3], as well as tests at subsystem level on the M2 unit, on the enclosure, on the telescope structure equipped with dummy mirrors, etc. [4].

With the commissioning of the first VLT telescope at Paranal, time has come to directly measure the dynamic stability of the 8-m telescopes in real operational conditions.

A dedicated commissioning task was undertaken on July 23–30 to monitor the mirror vibrations with highly sensitive accelerometers. A brief summary of the results is presented here.

2. Measurement Set-up

The measurement equipment consisted of eight high-sensitivity accelerometers (Wilcoxon 731A) connected to two digital acquisition units (DSPT SigLab 20-42) controlled from a PC running Matlab.

The accelerometers were placed as follows:

4 accelerometers attached at the outer edge of the primary mirror M1 sensing motion along the optical axis. The signals are averaged to obtain an estimate of the M1 axial displacement (piston).

1 accelerometer inside the M2 unit monitoring the motion of the mirror along the optical axis.

1 accelerometer on the M4 arm of the Nasmyth Adapter–Rotator sensing the motion along the normal of the future M4 mirror.

1 accelerometer on the M5 unit attachment flange sensing the motion along the normal of the future M5 mirror.

1 accelerometer on the M6 unit attachment flange sensing the motion along the normal of the future M6 mirror.

Post-processing was done using dedicated routines written in Matlab.

3. Main Results

Figure 1 shows the fringe visibility loss resulting from the mirror vibrations in various operational conditions and for three different observing wavelengths: visible (0.6 µm), near infrared (2.2 µm) and thermal infrared (10 µm). The VLTI error budgets call for a 1% visibility loss due to vibrations inside the telescope for any of these observing wavelengths. This corresponds respectively to an OPL variation of 14, 50 and 215 nanometers r.m.s.

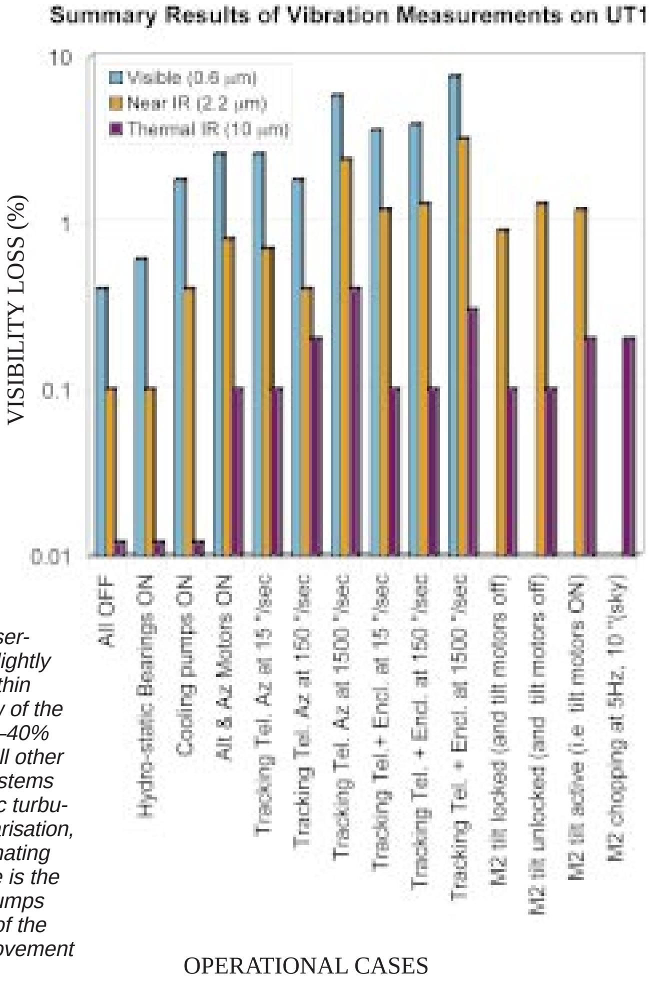

Figure 1: Summary of the results from vibration test on UT1 for VLTI application. The graph shows the total visibility loss due to mirror vibrations inside UT1 for three observing wavelengths (visible, near IR, thermal IR) and various operational conditions. The VLTI error budgets ask for a 1% visibility loss due to vibration inside the telescope. This corresponds to an OPL variation of 14, 50 and 215 nanometers r.m.s. for the three wavelengths respectively. This requirement is achieved in most cases for the IR ranges. For observation in the visible it is slightly exceeded but remains within acceptable margin in view of the global visibility loss of 30–40% which is aimed at when all other error sources and sub-systems are included (atmospheric turbulence, figuring errors, polarisation, delay lines, etc.). A dominating disturbance for the visible is the vibration of the cooling pumps located in the basement of the enclosure for which improvement can easily be achieved.

over 10, 48 and 290 msec for the three wavelength bands.

The left-most case marked *"All OFF"* on Figure 1 shows the results when basically all sub-systems of the telescope are switched off. It represents the contributions of the background environment noise. It is well below the 1% level for all wavelengths.

The second case shows the influence of the altitude and azimuth Hydro-Static Bearing System (HBS). The insignificant impact of the HBS is one of the most comforting results of these tests, since it was still largely unknown and potentially important, as indicated from results on other existing telescopes. The credit goes to the use of screw-type pumps, a good isolation of the pumps and careful overall design.

On the other hand, the third case shows a significant impact, for observation in the visible, of the liquid-cooling pumps located in the basement of the enclosure. It has been checked that these vibrations are mainly transmitted to the telescope through the ground and telescope pier and not through the distribution pipes fixed on the telescope structure. Here, easy improvement is possible by better isolation between the pumps and the ground and between the pipes and the telescope pier.

The next case shows a slight influence (especially at 10 µm, i.e. low-frequency disturbance) of the altitude and azimuth motors' noise. The exact origin of this low-frequency disturbance is still not fully understood but it will very likely improve when the bandwidth of the axis control will be increased to its nominal value.

From the tests performed during tracking of the telescope, we can conclude that the associated disturbance remains acceptable for IR wavelengths and remains dominated by the cooling pumps for the visible except for the highest speed of 1500″/sec which corresponds however to the quite exceptional case of observing at 0.5° from the zenith.

The next cases during which the enclosure was also tracking evidence a slight deterioration both for visible and near IR. Improvement in this area is possible by a better tuning of the enclosure rotation mechanism which, at the present stage, still produces audible noise.

The last cases shown concern the use of the M2 tip-tilt and chopping capabilities for interferometric observations in the Near IR (for atmospheric tip-tilt correction) and thermal IR (for background subtraction) respectively. It was originally planned to use smaller and lighter mirrors in the coudé train to perform these functions for VLTI because of the high OPL stability requirements. Tests on the M2 at Dornier in November 1997 [4] had shown, however, that the outstanding axial stability of the M2 during tilt and chopping should be good enough to use it for VLTI. The results presented here confirm this preliminary conclusion. Tip-tilt correction and chopping can be done with M2 for VLTI observation in the near IR and thermal IR, respectively.

Other sub-systems were also positively tested as to their impact on the OPL stability such as active optics during a typical correction, operation of louvers and windscreens, fans and transformers in electronic cabinets, etc. In this last category, it is worth mentioning the following anecdote. The first set of measurement was constantly showing a much-too-high visibility loss of typically 40% in the visible and 5% in the thermal IR. After extensive investigations, it was found to be caused by two cooling fans located in the electronic cabinets of the Test Camera attached at the Cassegrain focus. Contrary to most of the other cabinets, these are not vibration isolated due to the temporary nature of this first-light instrument. These small fans were able to excite the "pumping" mode of the 80-ton telescope tube at 40 Hz creating about 90 nm rms over 10 msec and 500 nm rms over 290 msec. This shows the importance of a careful design down to that level of detail.

Conclusion

Although these tests cannot be considered as the final ones since several mirrors were not yet installed (M3 and coudé train), they confirm the very strong potential of the VLT 8-m telescope to fulfil the very stringent stability requirement imposed by VLTI. Indeed, they show that the global vibration of the overall structure remains within an acceptable range. Any future problems which could appear should be of a local nature (e.g. resonance of a given coudé mirror cell) and therefore more easy to solve by appropriate local damping or stiffening. These tests also enabled us to identify, at an early stage, a number of possible improvements such as better isolation of the cooling pumps in the enclosure basement, stiffening of the M4 arm and improvement of the enclosure rotation smoothness.

References

[1] B. Koehler, "Hunting the bad vibes at Paranal", *The Messenger* No. **76**, June 1994.
[2] Koehler et al., "Impact of the micro seismic activity on the VLT Interferometer", *The Messenger* No. **79**, March 1995.
[3] Koehler, "VLTI: Chasing the nanometric vibrations on 8-m telescopes" in *Proc. Space Micro-dynamics and accurate Control Symposium (SMACS2)*, CNES, Toulouse, May 1997.
[4] Koehler, "VLT Unit Telescope, suitability for interferometry: first results from acceptance tests on subsystems", in Proc. SPIE Symposium on *Astronomical Telescope and Instrumentation*, Conf. 3350 "Astronomical Interferometry", Kona, March 1998.

The Wide Field Imager for the 2.2-m MPG/ESO Telescope: a Preview

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History

In November 1995, the *La Silla 2000* working group of the Scientific Technical Committee (STC) as well as the Observing Programmes Committee (OPC) identified a very strong demand by the ESO community for wide-field imaging (0.5–2 degrees) capabilities (cf. Andersen, J. 1996: *The Messenger,* No. 83, p. 48). In all major areas of research, the primary driver was the identification and preselection of candidate targets for more in-depth studies with the VLT (see also: Renzini, A. 1998: *The Messenger,* No. 91, p. 54). The OPC report remarked: *In any case, an array of CCDs of 8000 × 8000 will have to be constructed: This is feasible but will not be a small undertaking.*

The strong encouragement given to ESO to investigate possibilities of implementing such a facility could nevertheless not eliminate the fact that in ESO's mid-term planning hardly any resources were left that on the desirable short timescale could have been assigned to a new project. It was, therefore, timely that simultaneously the Max-Planck-Institut für Astronomie in Heidelberg (MPI-A) proposed to build a wide-angle camera for the MPG/ESO 2.2-m telescope. After some iterations on the general scope of the project, it was agreed that MPI-A would be responsible for mechanics, optics, and filters whereas ESO would provide the optical design, the complete detector system, and all of the control software. Later, the Osservatorio Astronomico di Capodimonte (Naples) joined the project as the third partner and fortunately was able to absorb the lion's share of the cost of the CCD detectors.

This article intends to give a concise preview of the result of these efforts. The commissioning of the new camera will

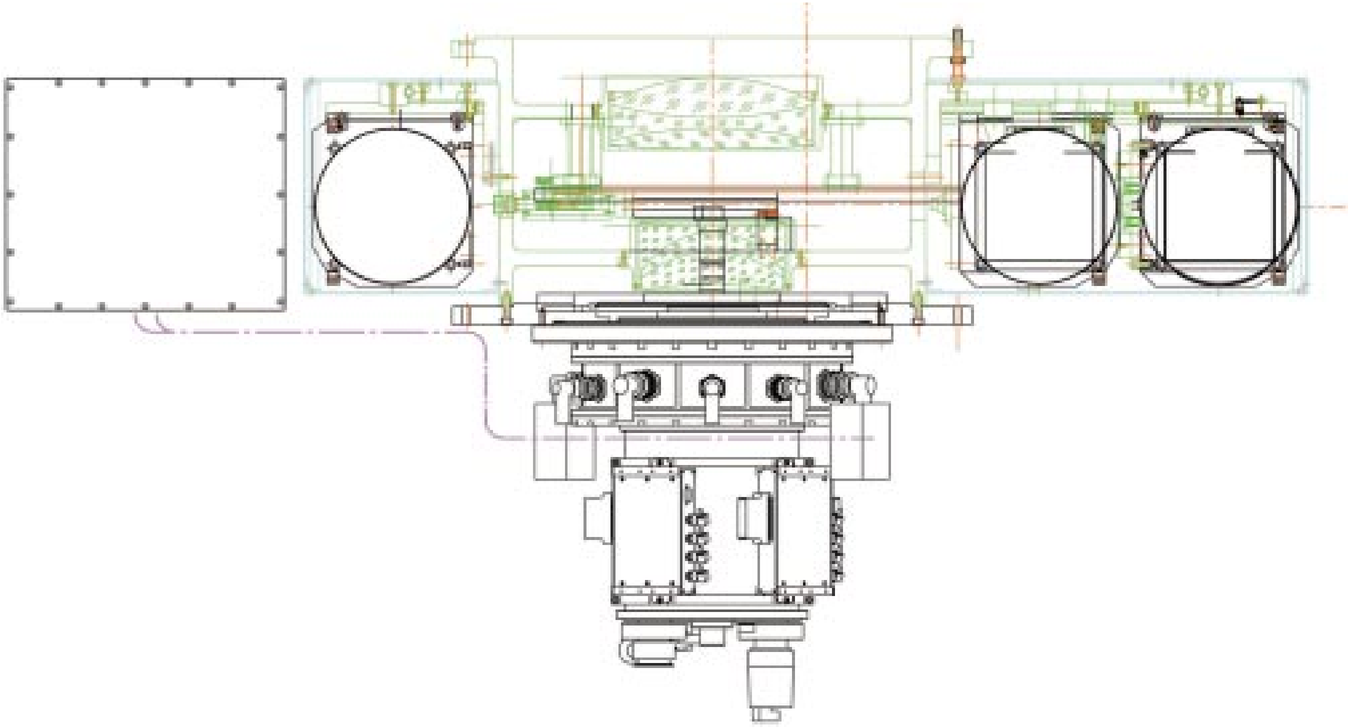

Figure 1: A schematic overview of the WFI. The left and the outer right circle are the apertures of filter holders mounted on the filter storage ring. The second circle on the right-hand side shows a filter after it has been moved out of the ring. It can then be rotated through 90 degrees out of the image plane, shifted to the left, and between the two triplets (shaded in green) inserted into the beam. The shutter is located right below the lower triplet. Next follows the cryostat head seen from outside with a number of vacuum connectors. The cylinder at the bottom (with a variety of attachments) is the liquid nitrogen tank. The large rectangle to the left is the FIERA control electronics box which also serves as a counterweight to balance the torque of the asymmetrically (with respect to the optical axis) located filter storage ring.

Figure 2: A view of the WFI filter exchange mechanism from the bottom and as assembled for first tests in spring 1998. The rectangle near the centre is a mount for interference filters (a dummy is visible) rotated into a plane perpendicular to the optical axis but outside the telescope beam; the recess for the filter intersecting the light towards the tracker CCD is on the left. The grooves at the top of the picture are located on the filter storage ring; there are fifty of them in total, and each can accommodate one filter. The rectangle in the upper right corner is a holder for the larger circular glass filters (with a dummy inserted) in its storage position. The filter ring can be rotated by means of the cogwheel in the upper left corner and the attached motor.

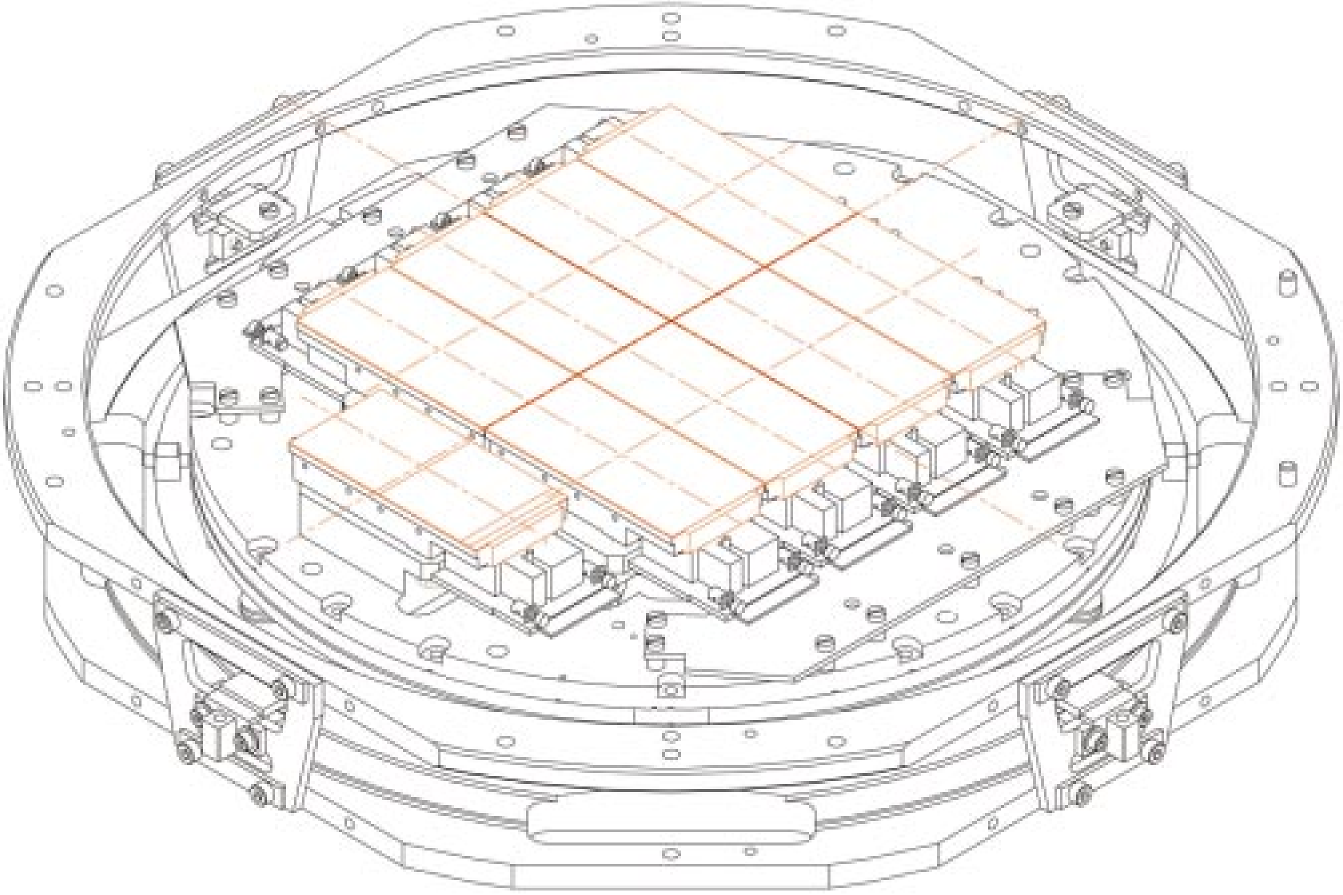

Figure 3: Partial drawing of the cryostat head of the WFI with the plate and sockets on which the CCD's are mounted. Two rows of four chips each form the science mosaic which measures about 12.5 × 12.5 cm^2. The extra CCD on the left front side is used for autoguiding.

take place in November and December 1998 (unfortunately, at the time of writing we were informed that a mishap during the manufacturing of one of the two triplets will probably produce this delay with respect to the original schedule), and first results will be reported in the March 1999 issue of *The Messenger.* The Wide Field Imager (WFI) will be the only instrument offered on the newly refurbished and upgraded 2.2-m telescope (cf. the report by the 2.2-m Telescope Team in this issue of *The Messenger).*

Optics

The optical design is essentially the one of a focal reducer with two triplets (a crude cross section can be seen in Fig. 1). It yields a scale of 0.24 arcsec per 15-µ pixel which over the field of view of 0.5 × 0.5 degrees varies by less than 0.1% (at 500 nm). From 350 nm to 1 µ 80% of the encircled energy falls onto a single pixel (except for the extreme field corners at long wavelengths). The throughput curve rises from 45% at 350 nm to 80% at 400 nm and thereafter remains flat through 1 µm.

Mechanics

Apart from providing the necessary support structure for the optics and protection against light and dust, the mechanics features two motorised functions (focusing is accomplished by moving the secondary mirror of the telescope). The first one is a large, roughly semi-disk-shaped shutter. It is designed to reach a precision of order 1 msec even for short exposures. The second one is the filter exchange mechanism. Up to 50 filters can be permanently mounted in a large rotating ring surrounding the camera (Fig. 1) where they are stored in a vertical position. An electromagnetic grabber can move a filter out of the ring, rotate it through 90 degrees, and slide it into the beam (Figs. 1 and 2).

Detector System

The focal plane is covered with a mosaic of eight 2k × 4k CCD44 devices from EEV. The pixel size of 15 µm matches the optical design. Figure 3 provides a 3-D view of parts of the cryostat head within which the chips are mounted. The gaps between the individual detectors (about 1.5 mm along the major and 0.8 mm along the minor axes) can be covered by multiple exposures with small telescope offsets. This procedure simultaneously allows cosmetic imperfections of the chips to be corrected for. Area-wise, the cosmetic defects are much less relevant than the inter-chip gaps. From 350 nm to 400 nm, the sensitivity rises from about 50% to 80% or above and only beyond 700 nm slowly decreases to slightly less than 30% at 900 nm; detectors and optics are not useful at wavelengths longer than 1 µm. The readout noise will be around 6 e^- per pixel, and the dead time for readout and file transfer to the instrument control workstation between consecutive exposures amounts to half a minute. Attached to the detector head is a liquid nitrogen-filled tank of the same type that is also used for many VLT instruments. All CCD functions are provided by ESO's standard FIERA controller and associated software.

Autoguiding

Besides the 2-by-4 science mosaic of CCD's, Figure 3 shows a ninth CCD on the western side (in right ascension). This so-called tracker CCD is of the same type as the other eight but has slightly lower cosmetic quality. It shares the shutter with the main detector array and is employed for autoguiding. Only the central 50% along the minor axis are unvignetted by the camera and the filter mount. But a sufficiently bright guide star can be placed anywhere on the chip. This CCD is controlled by the same FIERA system but completely independently so. A small window can be defined around the image of the star. After an integration, the duration of which is adjustable down to a fraction of a second, this window is shifted at a rate of about 40,000 rows per second to the readout register and then read at normal speed. The FIERA software automatically detects the star in this window, fits a Gaussian to it, and sends the results to the Telescope Control System which uses this information to let the telescope track properly.

Filters

In addition to glass filters, which in combination with the CCD sensitivity curve closely resemble the $B\ V\ R_C\ I_C\ Z+$ system (the U-band is broader than usual to achieve higher throughput), numerous intermediate- and narrow-band filters are foreseen. The complement of the latter will initially be incomplete but eventually cover the range from 370 nm to 930 nm in a quasi-continuous fashion suitable for the identification of high-redshift objects. A sub-set especially designed for this purpose is similar to the one described by Thommes et al. (1997, in R. Schielicke (ed.), Reviews in Modern Astronomy, Vol. 10, p. 297). A list of the filters available in Period 62 is provided on the WWW page referenced below. Glass filters are circular and also cover the tracker CCD. Medium- and narrow-band filters are square and do not extend into the guide star beam. Instead, a small separate glass filter is mounted in a corresponding recess in the holder so that the throughput is sufficient for autoguiding. In order to reduce differential atmospheric effects, the central wavelength approximates the one of the science filter.

Future Options

For Period 63, it is foreseen to test a set of linear polarisers. If the tests are successful, the polarimetry option will be offered in Period 64. Possibilities for slitless low-resolution spectroscopy are also being investigated.

The DAISY+ instrument and telescope control software environment and the control electronics of the 2.2-m telescope do not support low-level compatibility with the corresponding VLT systems. Therefore, a complete copy of the VLT Data Flow System (Silva, D., and Quinn, P. 1997: *The Messenger,* No. 90, p. 12) cannot be installed. However, in preparation for the VLT Survey Telescope (VST; *The Messenger*, this issue) to be erected on Paranal in the year 2001, which will have twice the field of view as the WFI, efforts are being undertaken for a partial implementation. The first step will be the development of a Phase 2 Proposal Preparation (P2PP) system. This will also enable suitable observing programmes to be carried out in service mode.

Updated information on the WFI will be made accessible via the WWW home page of the 2.2-m Telescope Team on La Silla (URL: http://www.ls.eso.org/lasilla/Telescopes/2p2T/E2p2M/WFI/news/WFI_P63.html).

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The La Silla News Page

The editors of the La Silla News Page would like to welcome readers of the eleventh edition of a page devoted to reporting on technical updates and observational achievements at La Silla. We would like this page to inform the astronomical community of changes made to telescopes, instruments, operations, and of instrumental performances that cannot be reported conveniently elsewhere. Contributions and inquiries to this page from the community are most welcome. *(J. Brewer, O. Hainaut, M. Kürster)*

News from the NTT

O.R. HAINAUT, ESO, La Silla

As the reader will notice, the "News from the NTT" are back in the La Silla News Page, marking the end of the "Big Bang" era (this major upgrade has been described in *The Messenger* Nos. 75–91). The NTT is now fully returned to the La Silla Observatory. With this, another era is finishing too: Gautier Mathys has left the Team. After 5 years at the NTT (i.e. since the beginning of the team itself), many of these as local representative of the Team Leader, and the last year as Team Leader, Gautier is now preparing the scientific operation of the VLT UT1 at Paranal. His excellent leadership, and his extensive, boundless and all-encompassing knowledge of the NTT systems will be missed by the Team. Since the 1st of August, the author has taken over the duties of NTT Team Leader; he will aim at continuing Gautier's work to improve the reliability and user-friendliness of the Telescope, while maintaining the full compatibility with the VLT environments.

During the past months, SOFI, the NTT infrared spectro-imager, has received its first visiting astronomers. The instrument proved to be extremely efficient, as illustrated by the paper by Chris Lidman in this issue of *The Messenger*. Its "second generation" observation templates, which make full usage of the interactive capabilities of the "Real Time Display", constitute an intuitive and effective interface that allows the observer to efficiently master all the modes of this instrument.

After its commissioning in January, SUSI2 experienced a series of problems, including loss of vacuum, sometimes accompanied by sudden warming up. These were caused by the rapid contraction of the O-ring sealing the dewar, which happens when some LN2 is spilled over them, e.g. when re-filling the instrument, or when moving it when it is still full. This problem should be solved by the end of August, with the installation of a dewar with improved O-rings and equipped with a device limiting the LN2 spilling. We should then be able to take full advantage of this new-generation dewar, capable of keeping the instrument cold for 48 hours.

A series of improvements of the system have also been implemented; a few examples and highlights follow:

- The CCD monitoring, which had received no new developments since the departure of Griet van de Steene in January 1998, has been taken over by Vanessa Doublier. Our three CCDs are now monitored weekly, and the results of these tests, including bias level, read-out noise, shutter delay and sensitivity, are presented on our instrument Web pages. We plan to continue implementing more tests into this monitoring of the detectors, as well as adapt it to the SOFI IR array.
- The focus offsets between the Image Analysis cameras and the scientific detectors has been measured. These offsets have been found extremely stable for SUSI2, while for EMMI and SOFI they show some slight variations with the rotator angle. It reflects the greater complexity of these instruments, which are subject to minor internal flexures. The Active Optics system is now calibrated to take these focus differences into account. As a consequence, the telescope is automatically focused while performing an image analysis.
- Various monitoring and technical templates are being developed to perform operation and maintenance tasks in a more efficient way.

Finally, a point that will be of interest for the observers: the new versions of the EMMI and SOFI manuals are undergoing their final revision and should be available on the NTT Web pages by the time these lines are printed.

SOFI Receives its First Users

C. LIDMAN, ESO, La Silla

SOFI, the recently commissioned IR imager and spectrograph on the NTT, started regular service on June 6 this year. Since then, about a dozen visiting astronomers have successfully used the instrument.

All modes of the instrument, which includes broad- and narrow-band imaging, low-resolution spectroscopy and imaging polarimetry, have since been used.

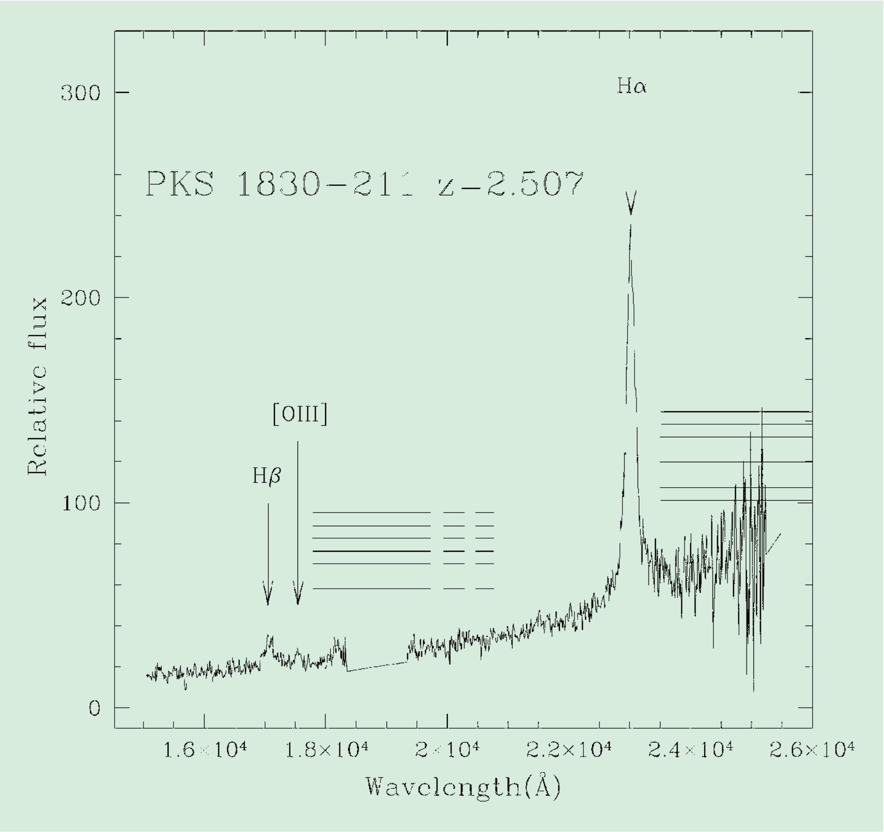
To date, the instrument has been used to study objects as varied as supernovae, proto-planetary nebulae, embedded stars, dwarf galaxies, gravitational lenses, high-redshift clusters and the star-formation rate at high redshifts.

Of particular note was the observation of the well-known Einstein ring

PKS1830-211 carried out by a team of astronomers headed by Frederic Courbin (Université de Liège). This team includes George Meylan from ESO Garching, Tom Broadhurst and Brenda Frye from the University of California at Berkeley and the author of these lines.

The optical identification and the redshift of PKS1830-211 has been long sought by astronomers. The optical-IR counterpart of PKS1830-211 was discovered last year through images taken with IRAC2b. The optical-IR colours suggested a significant amount of extinction. This was the impetus to take a spectrum with SOFI.

The following plot shows a spectrum of PKS1830-211 spanning the wavelength range 1.5 to 2.5 microns. It was taken with the red grism of SOFI. The exposure time was 24 minutes and the source is near 15th magnitude at K. In the plot, redshifted Hα and Hβ are clearly detected at $z = 2.507$. Other lines, such as [OIII] may also be visible. The horizontal lines mark regions where atmospheric absorption is strong: the region near 1.9 microns and the region beyond 2.5 microns are almost totally opaque, so the data in these regions have been deleted.



This new result, together with the known redshift of the lens (measured by molecular absorption at mm wavelengths – F. Combes and T. Wicklind 1998, *The Messenger* 91, p. 29) and continuing efforts to get a secure time delay, means that we are a step closer to the goal of determining H_0 from this lens.

3.6-m Telescope Passes Major Upgrade Milestones

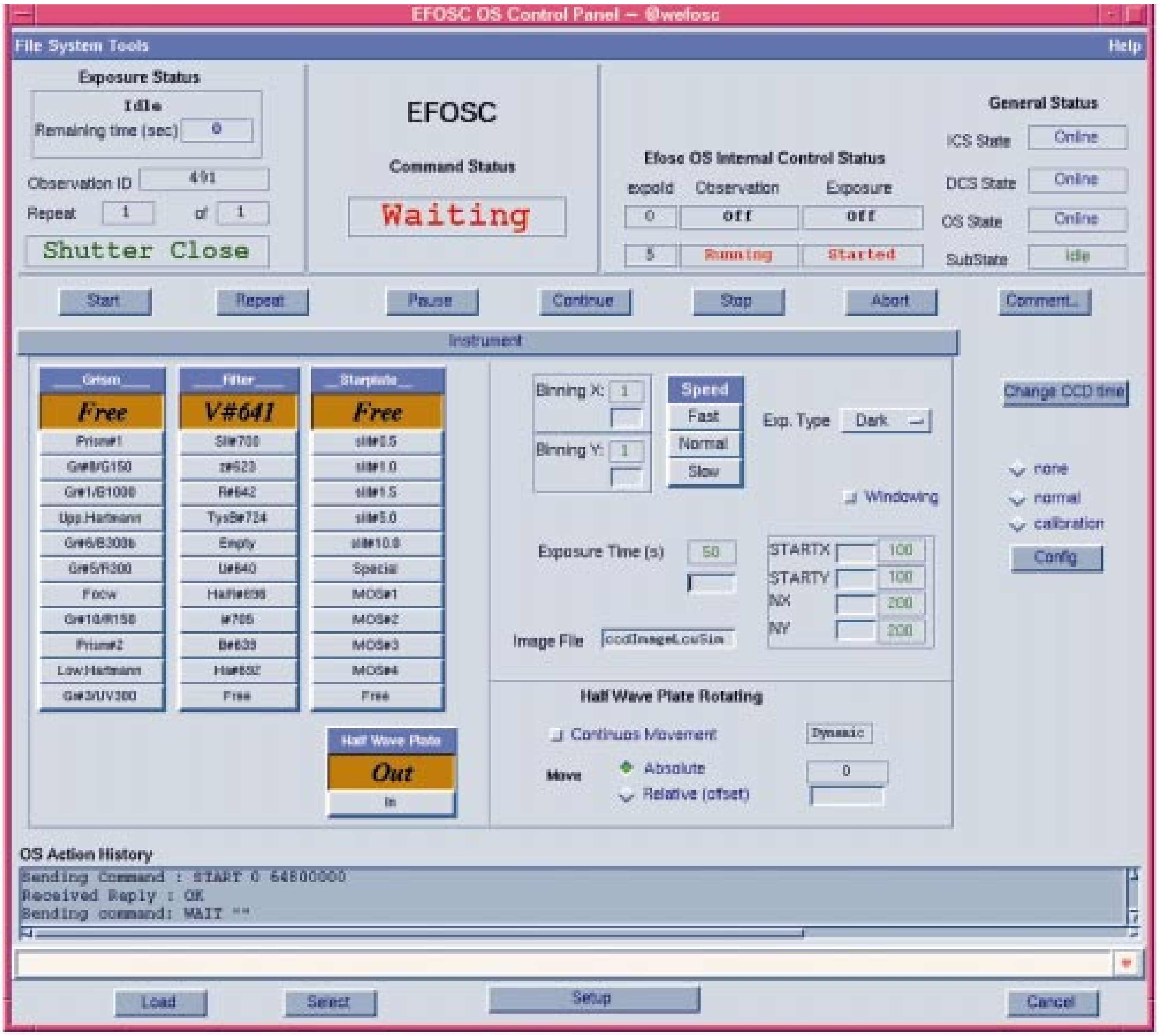
M. STERZIK, ESO

During two months of technical time in July and August, major steps in the 3.6-m telescope upgrade plan were successfully passed. I shortly recall the objectives for the 3.6-m upgrade project (see *The Messenger* 85, 1996, p. 9): (i) optimisation of the mechanical and optical performance to improve the image quality (IQ), (ii) operational stability and efficiency to minimise downtime and maximise scientific return, and (iii) offer competitive instrumentation. After the upgrade, the 3.6-m telescope will return to the forefront of 4-m-class telescopes in the beginning of the next century.

All the work done during the last months was in that direction. Thanks to the careful project planning of Ueli Weilenmann, all milestones foreseen in the technical time could be passed. A major **opto-mechanical improvement** was the successful installation of an active pressure control system for the M1 lateral pad support. M1 movements in the mirror cell are now practically eliminated. Tests demonstrate that already in open loop the force distribution onto the lateral mirror support can be controlled at a level of, typically, 20 kg difference between theoretical and measured forces, and further reduced to 2 kg in closed-loop configuration. (With the old REOSC system, force differences of 300 kg were typical.) This control is of crucial importance for the IQ at larger zenith distances. For the presentation of impressive IQ results, please refer to the ongoing series by Stephane Guisard in *The Messenger*. At this moment, I rather wish to stress that already now sub-arcsec IQ is routinely possible at the 3.6-m telescope for scientific work (as long as the external seeing conditions allow). Considerable progress was also made in increasing the mechanical stability of the guide probe, now allowing reproducible movements with an accuracy below 0.2 arcsec. Here, thanks go to the La Silla mechanics and optical support teams, who solve many problems promptly and thoroughly.

Another central issue related to **telescope control software** (TCS) was the installation and commissioning of the TCS under NOV97 VLT-Common Control Software. This includes the workstation part of the telescope interface, and the part related to the local control units of adapter functions. The conceptual complexity of the VLT software is well known, and it is obvious that adapting this software to the specific requirements of the 3.6-m telescope is not straightforward, and sometimes leads to hiccups. For example, a reliable interface of the front-end VLT-software with the still operating HP1000-based TCS (which still controls the telescope in the back-end, i.e. “moves” the telescope), is a demanding task and a potential source of problems. It is the price to pay in the approach taken for the 3.6-m upgrade: to offer the telescope to the community largely in parallel with the upgrade. And here, I would like to express my gratitude to the highly committed software team at La Silla who successfully accomplished this challenging task with limited resources.

A part of the software upgrade is the implementation of a fully VLT-compliant **instrument control software** (ICS) for EFOSC2. This is the most striking change that observers will experience when



Idle
Remaining time (sec) 0
Observation ID 491
Repeat 1 of 1
Shutter Close

Waiting

expoId 0 5
Observation off Running
Exposure off Started

ICS State Online
DCS State Online
OS State Online
SubState Idle

Grism: Free
Filter: V#641
Starplate: Free
Half Wave Plate: Out

Binning X: 1
Binning Y: 1
Speed: Normal
Exp. Type Dark
Exposure Time (s) 50
Image File ccdImageLcuSim
STARTX 100
STARTY 100
NX 200
NY 200
Move: ● Absolute 0

```
Sending Command : START 0 64800000
Received Reply : OK
Sending command: WAIT ""
```

Figure 1.

working with the instrument starting this September. The old HP1000 control is replaced by a GUI-based instrument control panel (Fig. 1) that allows full control over a multitude of EFOSC2 functions such as changing grisms, filters, and slits. It provides an elegant way to adjust the half-wave plate for polarimetry and allows full control over the CCD.

But it is not only the EFOSC2 cosmetics that have changed; new grisms offer higher efficiencies, and a brand new FIERA CCD controller dramatically speeds up read-out times, a bottleneck for some programmes in the past (see *The Messenger* 83, 1996, p. 4*)*. Most important, the whole observing philosophy changes with the advent of the new ICS: it converges to the observing modes known from the NTT, and employed at the VLT. Visiting astronomers observing with EFOSC2 will be asked to prepare their observations (together with the help of on-site support astronomers) in advance with the Phase 2 Proposal Preparation (P2PP) tool. P2PP in visitor mode will support EFOSC2, and serves to combine so called observing templates (scripts that contain a predefined sequence of operations that control the telescope, the instrument, and the detector) in Observing Blocks (OB), which are minimal entities that describe meaningful scientific observations. The EFOSC observing templates were developed by the 3.6-m team (the NTT/EMMI templates certainly helped a lot to speed up their creation) within a very short time in July and August. Not all glitches could be removed during the commissioning of the ICS, as the complex communication between all subsystems requires that we gain more experience, especially with the response times occurring in the many possible configurations. I apologise for any inconvenience that may be encountered, but already now most observation programmes will benefit from our effort. The most common observing modes of EFOSC2 (imaging and long-slit spectroscopy) are supported by templates. They can be planned and executed in a more efficient way and are less error sensitive. We are interested in learning the responses of the community, and intend to further improve and extend this service. Stay tuned and look up the WEB (http://www.ls.eso.org/lasilla/Telescopes/360cat/html/3p6VLT.html).

The operation of EFOSC2 is, conceptually, embedded in a more complex data-handling concept, known as the Data Flow System (DFS) from NTT/VLT, and described e.g. by D. Silva and P. Quinn *(The* Messenger 90, 1998, p. 12). It includes a transfer chain incorporating a reduction pipeline and archiving tools. In the future, this functionality is planned in the framework of a La Silla wide data-handling and -archiving system. For the time being, astronomers will obtain their data on DAT tapes in a more conventional fashion at the 3.6-m telescope.

Let us now look at the **near future** of the 3.6-m telescope: more and more TCS functions (interlock system, tracking LCU, telescope servos) will be incorporated into the new control system. The HP1000-based TCS will be fully abandoned next April. Already this year we plan to move the control room (next to the telescope on the cold observing floor) to a spacier, more comfortable room located on the third floor. New furniture will underpin the modern "look and feel" when observing with a telescope having one of the most advanced control systems. Regarding instrumentation, the CES will be the next awaiting VLT-compliant instrument control. A fibre-link to the Cassegrain-adapter of the 3.6-m telescope has already been installed, and the final commissioning will take place this October. Then EAGAL (ESO And GSFC ALADDIN Camera), a new near IR camera for the 1–5 μm wavelength range, and mainly foreseen in conjunction with the ADONIS adaptive optics system, and TIMMI2, the more sensitive successor of the old Thermal Infrared Multi Mode Instrument, will arrive. They will offer exciting and complementary facilities, especially important to bridge the gap until the VLT goes fully into operation. The 3.6-m telescope will remain a cutting-edge telescope in its class, and will gain further importance when science priorities like the High Accuracy Radial velocity Planetary Search (HARPS) programme are conducted at this telescope.

The last few months saw major **personnel movements** in the 3.6-m team. Roland Gredel, team leader of the 3.6-m+CAT Team since 1997, left La Silla in order to assume responsibility as director of the Calar Alto observatory in Spain. On behalf of the 3.6-m Team, I wish him all the best in this new challenge. His function will be taken over by the author of these lines.

At the same time, two new fellows joined the Team: Olivier Marco, now responsible instrument scientist for ADONIS, and Ferdinando Patat, who already played a key role in producing observing templates for EFOSC2. He takes over the responsibility as EFOSC2 instrument scientist. The 3.6-m Team welcomes its new astronomers.

2.2-m Telescope Upgrade Started

The 2p2team, ESO, Chile

On 15 July 1998 the upgrade of the MPG/ESO 2.2-m Telescope was started at La Silla. This project was launched late last year in order to:

- modernise telescope equipment,
- replace worn-out parts and units which malfunction frequently after being in service for more than fifteen years,
- prepare the telescope for the reception and operation of its future only standard scientific instrument, the Wide Field Imager (WFI), a half-degree imager equipped with an 8 × 8K CCD (see separate report on the WFI in this issue).

The goal is to run the telescope in a modern VME based control environment which will allow the use of a VXWORKS based telescope control system (TCS) and a simple interfacing to the WFI instrument control environment. As a baseline, the 2.2-m TCS will follow the concept of the TCS for the Danish 1.5-m telescope, but will be considerably modified and improved in order to support the autoguiding system of the WFI, the automatic guide-star selection through guide-star catalogues, the new absolute encoders, and the modernised telescope safety system. Since the WFI will finally be operated in service mode, precautions in the TCS are made to interface accordingly with the new instrument control system DAISY+ which is an advanced version of the existing La Silla instrument control package DAISY (currently in use at the Danish 1.5-m, the Dutch 0.9-m, and also foreseen for the B&C and FEROS instruments at the ESO 1.5-m).

During the past 8 months, La Silla engineers, technicians and astronomers analysed the status and health of the telescope optics and electromechanics, made the design of the new equipment and programmes and prepared the hardware and software for the implementation of the upgrade.

While the telescope optics was found to be of excellent intrinsic quality (optical aberration of below 0.2 arcsec is routinely measured during image analysis tests at this telescope), the electromechanics and telescope control system (computers and software) needed a major overhaul and replacement. The mechanics overhaul concentrates on the gearbox of the alpha drive (the worn-out alpha gear was replaced on 18 July 1998), the hydraulics system, the installation of new encoders (now also at the telescope adapter/rotator unit). The telescope electronics will be based on VME technology and it will receive a new dome control system as well as a distributed system of environmental sensors for the registration of the temperature and humidity at the telescope, instrument and inside/outside of the dome. Furthermore, a major clean-up of the whole telescope cabling is foreseen. On the software side, the TCS is adapted to the new logics of the telescope and instrument control, while interfaces to the DAISY+ software are added. The computer platform for the telescope and instrument control will be based on Hewlett Packard (HP) workstations inserted in a local network that supports high data transmission rates as needed for the WFI (a single WFI image is about 130 MB in FITS format and will be read out by the ESO FIERA CCD controller in about 30 seconds). Beside the HP735 workstation for the TCS, HPC200 and HPJ2240 workstations each equipped with 108 GB disk drives and 35/70 GB DLT units will serve as data acquisition and data reduction machines for the WFI and will provide support to the users for the on-line inspection through a real-time display (RTD) and for the on-line analysis by means of standard image processing packages like MIDAS, IRAF and IDL. Last, but not least, the control room will be refurbished such that both people and electronics will work in the environment as needed and most comfortable for a successful operation.

The upgrade is underway: after the hardware modifications and installations at the telescope, a test period of about 1 month will start by the end of August 1998 in order to tune and verify the telescope optics and electromechanics in the new control environment. Thereafter, the telescope is – hopefully – ready for the commissioning of the WFI which will arrive at La Silla in the last quarter of 1998.

Near-infrared instrumentation is now no longer offered at the 2.2-m: IRAC2, ESO's near infrared array camera which was a workhorse instrument of the 2.2-m for many years, was decommissioned in mid-July 1998 (it is replaced by the more powerful SOFI instrument at the NTT).

The 2.2-m telescope upgrade team consists of: J. Alonso (project manager), J. Araya, T. Augusteijn, H. Boehnhardt, J. Brewer, R. Castillo, H. Kastowsky, F. Labraña, M. Mornhinweg, R. Olivares, F. Richardson, E. Robledo, A. Torrejon.

The following LSO teams and ESO persons are supporting the project: LSO Electronics (R. Medina), LSO Mechanics (G. Ihle), LSO Optics (A. Gilliotte), LSO Software Support Group (G. Lundqvist), LSO Infrastructure Group (F. Luco), LSO Management (G. Andreoni, J. Melnick), ESO Garching (D. Baade).

THE ESO AND ST-ECF ARCHIVES

The ESO Archives and the ST–ECF Archives have been closely integrated within the framework of the DMD, resulting in increased coherence and efficiency.

There is joint operation of the ESO and ST–ECF Archive while the development – which is necessarily instrument specific – is separate. In numerous instances, however, the procedure and software developed for space data can be adapted to ground-based data and reciprocally (e.g. OTF or Associations).

This series of articles reports on recent advances.

ESO and ST-ECF Archive News

B. PIRENNE[1, 2], M. ALBRECHT AND B. LEIBUNDGUT[1]

[1]ESO/DMD, [2]ESO/ST-ECF

During the past year, many changes took place at all levels in the area of data archive. A major structural re-organisation, many new achievements in the area of VLT readiness and quite a few important and interesting features for HST archival data users have been implemented.

1 Preparing for the VLT

1.1 Re-organisation

A tighter integration of the operational side of the ESO and ST-ECF archives has now been officialised even though the hard- and software systems used were already common to both before. Now both groups take part in the HST and ESO NTT and VLT archive operations. ESO continues to invest in manpower and systems benefiting both HST and ESO archives. The ST-ECF does the same. The new Science Archive Operations group (SAO) is formally integrated into the ESO Data Management Division, Data Flow Operation group. This group is headed (since July 1) by Bruno Leibundgut. Besides running the archive, this group will bear responsibility for running the Quality Control of the VLT data. The re-organisation affected the entire DMD and the global strategy was described in the March 1997 issue of *The Messenger*, p. 12, by D. Silva and P. Quinn.

2. New HST Archive Developments

In accordance with the new orientation of ST-ECF decided in 1996 at the mid-term review, we have embarked in many large projects aimed at adding value to HST data, improving its access and helping the HST users community. Some of these activities are described in the papers by Alberto Micol and Markus Dolenski in this issue of *The Messenger* (“HST Archive News: WFPC2 Associations”, “HST Archive News: On-the-Fly Recalibration of NICMOS and STIS Data”).

Most important of all, the “WFPC2 Associations” project results have now been released. Thanks to the logical grouping of WFPC2 exposures, we can offer our users not only a more meaningful catalogue browse response, but also automatic cosmic-ray rejection, drizzling and assembling of multiple exposures upon retrieval of the data.

This new service complements the now standard on-the-fly re-calibration (OTF), presented in previous issues of the ST-ECF Newsletter. Improvements in this area now include STIS and NICMOS, which are available as presented in Table 1.

The completion of the WFPC2 associations’ project required an additional development and operational effort, which has now reached completion: the generation of the missing jitter files. They represent the basic building block for our classification of the WFPC2 exposures, but unfortunately, 10 months of such data were missing, which we have been able to regenerate thanks to a fruitful collaboration with the STScI.

Presentation of information has also received some attention: New Java “applets” to access the “PreView” images of our archives from a web browser have been made available. They are described

TABLE 1: Services available and their pointers.

Service Name	Type of service	Description	URL
GSC-I	Catalogue	The 20-million objects Guide Star Catalogue	`http://archive.eso.org/gsc/gsc`
USNO	Catalogue	US Naval Observatory Catalogue (500 million objects)	`http://archive.eso.org/skycat/servers/usnoa/`
DSS-1	Survey	1st generation Digital Sky Survey	`http://archive.eso.org/dss/dss`
DSS-2	Survey	2d generation DSS (higher/res). Not yet complete	`http://archive.eso.org/dss/dss`
HST	Data Archive	Hubble Space Telescope archive (with PreView, on-the-fly re-calibration and WFPC2 associations’ capabilities).	`http://archive.eso.org/wdb/wdb/hst/science/form`
NTT-old	Data Archive	Pre-Big bang NTT data archive and catalogue. Should be integrated in the new NTT/VLT archive soon	`http://archive.eso.org/wdb/wdb/eso/eso_archive/form`
VLT/NTT	Data Archive	New VLT and post-Big Bang. NTT archive and catalogue	`http://archive.eso.org/wdb/wdb/eso/observations/form`

in more details in Markus Dolensky's article on "HST archive services implemented in Java" in this issue.

3. Other Archive Developments

3.1 GSC-II participation

In the framework of the ESA-NASA MOU renewal on HST, ESA is contributing to the completion of the Guide Star Catalogue II planned as a 2-billion object, fully homogeneous (both photometrically and astrometrically), all-sky, multicolour catalogue. The ST-ECF is involved in this major scientific endeavour by operating a pipeline that extracts the objects and by doing the quality control of about half of the 6000 photographic plates used for the generation of the catalogue. More details concerning the participation of the ST-ECF in this project are given in the article entitled "ST-ECF Participation in the GSC-II Generation Project" in this issue.

On the development side, the ESO archive is also contributing a storage method for the future export catalogue: the system will allow the storage of the entire catalogue on less than 50 GB of disk space.

3.2 Archive storage media change

The ESO/ST-ECF archive is now studying the promise of the DVD-R (Digital Versatile Disk) for astronomical data storage. The new capacity needs generated by the VLT instruments and the survey telescopes are prompting us to look into new denser yet affordable storage technologies. The prospects of the DVD are presented in "Using DVD Technology for Archiving Astronomical Data" in this issue of *The Messenger*.

4. Services Available from the ESO/ST-ECF Archive

Among the new services available from our archive, it should be noted that the post-Big Bang NTT archive data are now public. We would appreciate feedback on its usage. As a reminder, as this issue will be distributed, work on the preparation of the VLT Science Verification (SV) data will be continued. The data will be made available to astronomers from the ESO community as early as October 1. The plan is to have one set of the CD-ROM containing the SV data set sent to all the member state's astronomical institutions or university departments.

All the other services available from the ESO archive world-wide web are listed in Table 1 with their category, description and URL. For the possibility to use other, non-interactive client programmes for some of these services, please contact the authors.

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The VLT Data Volume

M. ALBRECHT, ESO/DMD

The VLT will be a remarkable observing facility in many ways. Among others, the volume of data generated by its instruments will make the VLT Science Archive one of the largest data sources in astronomy. Table 1 summarises the estimated data rates (Gigabytes per night) expected from VLT instruments over the next 4 years. In estimating the data output of a given instrument, assumptions have been made on typical usage modes, e.g. infrared instruments would produce larger numbers of frames because of commonly used sky/object observing sequences. Also, for each telescope a typical mixture of usage of alternative focii has been estimated in order to obtain a total volume expected from the complete facility. MIDI and AMBER, the two first VLTI instruments (to see first light in 2001), could produce of the order of 40 GB raw

TABLE 1: Estimated data rates (GB/night) expected from VLT instruments over the next 4 years.

		1999	2000	2001	2002
UT1	ISAAC	4	4	4	4
	FORS1	0.5	0.5		
	SINFONI			0.5	0.5
	CONICA/NAOS		1.5	1.5	1.5
	CONICA (SPECKLE)		40	40	40
UT2	TESTCAM	0.5	0.5		
	UVES	2.5	2.5	2.5	2.5
	FORS2	0.5	0.5	0.5	0.5
	FLAMES			2	2
UT3	TESTCAM		0.5	0.5	
	VIMOS		20	20	20
	VISIR			1	1
UT4	TESTCAM		0.5	0.5	
	FORS1			0.5	0.5
	NIRMOS			48	48
	CRIRES				0.5
VST	WFI			3.8	15
	VLT TYPICAL MIX (GB/NIGHT)	**3.0**	**19.1**	**59.3**	**70.6**

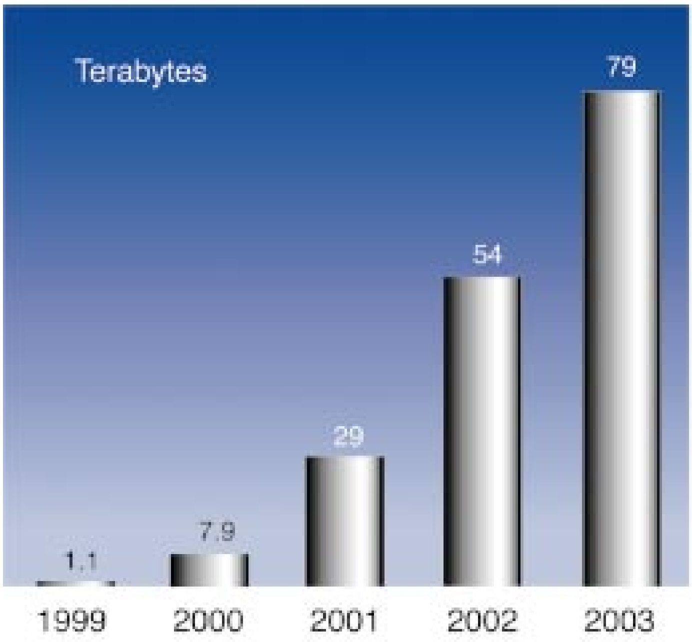

Figure 1: Cumulative data volume of the VLT Science Archive over the next 5 years.

data per night. They are not yet included in the table due to the uncertainties in their modes of operation. (The last line of the table includes VST output.)

When seen in the perspective of the cumulative data volume, these figures reveal the true dimensions of the facility. Figure 1 shows the estimated amount of data flowing into the VLT Science Archive in the years to come. For comparison, the total volume of the HST Science Archive after 8 years of operations is about half a terabyte in size (see article on “HST On-the-fly recalibration″ by Micol et al. in this volume).

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Using DVD Technology for Archiving Astronomical Data

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Background

Due to the slow evolution of some astrophysical phenomena, long-term preservation of observations has always been a major concern of observatories around the world. Be it hand-drawings on paper or 19th-century glass-plate photographs, the issue at stake is how to best preserve data for the future generations.

The advent of digital imaging and recording equipment in the second half of this century has provided both more observations and denser data storage media. These media can therefore no longer be read by the human eye. Moreover, with no immediate readability to the unaided eye, digital recordings require specific equipment to decipher their content. If a lot of progress has been made in the past decades to manufacture long-lived data storage media, the same is not true for the reading/writing equipment, quickly reaching obsolescence, and the repair of which is rapidly becoming impossible. This apparent contradiction between durable media and transient reading equipment is easy to understand if one realises that the media is usually “passive” whereas the reading device is always active, with mechanical components.

Archivists must therefore reconsider storage technology every few years: a transposition of the archive content from endangered media to the newest technology has to be undertaken almost every three to five years. Another major factor pushing towards migration of data to new technology is costs: the cost of the new technology compared to the old one often brings savings per unit of volume of up to an order of magnitude and are a strong motivation for migration.

Current Situation

In the case of the ESO/HST Science Archive in Garching, since 1988, three different storage media have been used and migrated from/to: The 2GB LMSI 12″ Optical disk, the 6.4 GB Sony 12″ optical disk and the current 0.64 GB CD-R in juke boxes. The reasons for migrating from one to the other are given in Table 1 below.

We abandoned the 12″ optical disk in favour of the more common 5 1/4″ CD-R for two reasons. On the one hand, CD-R were enjoying an international standard defining the way their content should be laid out (ISO 9660). This was a guarantee of durability and multi-vendor support. On the other hand, the possibility of having all the data on-line in juke boxes was finally an affordable possibility as the cost of juke boxes for 12″ optical disks was prohibitive for our archive system (see right-most column of Table 1). This last reason sealed the fate of hardware compatibility with the HST archive at the ST ScI where the data are still on 12″OD in jukeboxes.

However, now that we have completed the migration to CD-R, we are faced with another concern: the data rate growth. The VLT and HST instruments, soon to be commissioned, will produce several TB worth of raw data per year. We could not practically keep these data using CD-ROMs in juke boxes without making major infrastructure investment in storage buildings!

The solution that addresses the density problem and keeps the advantage of the CD-R technology (direct access medium, cheap juke box capability) is the DVD.

Digital Versatile Disk (DVD)

The DVD technology has been very long to come, heralded as it was by the specialised press for a number of years already. However, various disagreements within the industry and disputes around copyright issues have considerably slowed the introduction of this technology. A few months ago, however, equipment to record one’s own media (the DVD-R (see Table 2 for a brief description of the variants) became available. Our archive facility was understandably quick to procure and test the equipment and prepare the necessary software to support the device (from Pioneer Corp.). Even now, little support is available. The DVD-R can only be called such if its file system is compliant with the UDF file system. However, software drivers to support this format for both read and write are hardly available. To our knowl-

TABLE 1: The various data storage technologies used so far at the ESO/ST-ECF Archive Facility. Shaded areas represent the solutions actually implemented.. Units of cost represent an arbitrary monetary unit set to 100 per GB for the most expensive solution.

Medium Name	Reason for choice/migration to	Cost per GB	Cost per GB
		without Juke box	with Juke box
2GB/vol LMSI 12″ optical disk	Direct access, best of technology back then. In sync with ST ScI and HST archive	17	100
6.4GB/vol Sony 12″ optical disk	Direct access, factor of 2–3 cheaper to operate, previous technology difficult to maintain. In sync with ST ScI and HST archive	8	34
0.6GB/vol 5 1/4″ CD-R	Jukebox allows for online, no-operator-required access, ISO standard for file system	0.6	7.8
4.0GB/vol 5 1/4″ DVD-R	Much higher density, keeps direct access advantage of CD-ROMs	2.2	2.8

TABLE 2: The Jungle with acronyms

Acronym	Meaning	Description
CD	Compact Disk	Mass produced (Audio) CD
CD-ROM	Compact Disk - Read-Only Memory	Mass-produced (silver) CD-ROM
CD-R	CD Recordable	Write-once, read-many CD
CD-RW	CD ReWriteable	Re writeable CD-ROM
DVD	Digital Versatile Disk	Mass-reproduced Video medium
DVD-ROM	DVD Read-only Memory	Mass-reproduced data disk 4.7, 9.4, 18.8 GB.
DVD-R	DVD Recordable	recordable DVD (3.95GB)
DVD-RAM	DVD random access memory	re-writeable DVD (2.6 GB)
DVD-RW	DVD re-writeable	re-writeable DVD (??)

edge only the latest version of the MacOS operating system has genuine support for it. The Unix world so far enjoys no support.

In order to obtain quick results and to be as compatible as possible with the existing archive tools and procedures we are using, we took a pragmatic approach: we contacted the developer of a public-domain CD-R recording tool “cdrecord” (a popular Linux tool, see below) and arranged with him to extend his software for the production of DVD-Rs as well. Within a few months, a workable system was delivered to us. However, due to the lack of software support for the DVD native UDF file system, we are using the standard CD-ROM format (650MB ISO9660) extended to 4GB. To the host computer, our “DVD-R” once written simply looks like an unusually large CD-ROM.

Projects and Schedules

The most pressing and demanding project in our archive for high-density storage media at the moment is the future 2.2-m telescope mosaic camera that will be commissioned in La Silla starting this October. If our tests and prototypes, together with juke box support are positive, the DVD technology will be the system of choice for this particular archive. Also, we have started to migrate the NTT archive from the current Sony 12″ optical disks to DVD. By the time this issue of *The Messenger* is distributed, we will have copied a few dozen Sony 12″ optical disks onto the new medium.

We still expect to have full UDF support later in 1999. Our current experience shows that the computer operating system will probably transparently identify and mount media using any of the standards. So the co-existence in the same jukebox of CD-R, DVD-R with ISO9660 and plain DVD-R with UDF should be no problem.

The next step, in 1999 or 2000 will be the gradual migration of our CD-Rs onto the new medium to save jukebox storage space, as this is by far still the largest part of the storage cost of CD-Rs.

For more information about this system, please contact the authors (`bpirenne@eso.org` or `malbrech@eso.org`). Information about “cdrecord” can be obtained from Jörg Schilling (`schilling@fokus.gmd.de`). The DVD-R recording device we are using is Pioneer model DVR-S101.

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How the Analysis of HST Engineering Telemetry Supports the WFPC2 Association Project and Enhances FOS Calibration Accuracy

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Introduction

The analysis of Hubble Space Telescope (HST) engineering telemetry at STScI is a process that evolved over time since launch in April 1990. Today a jitter file is computed for every dataset by a system called Observatory Monitoring System (OMS). The jitter files, produced to study the telescope pointing stability and the trends in the telescope/instrument performance within the orbital environment, are available for datasets taken after October 1994. These files are supposed to contain sufficient information for an astronomer to properly reduce scientific data.

This has two implications:

1. Jitter files for datasets before October 1994 are either missing or were computed differently.
2. Engineering parameters that are not part of the jitter files cannot be retrieved from the HST archive.

This article shows what kind of problems this can cause, and more importantly, how these problems were solved in case of the WFPC2 Association Project as well as the FOS Post Operational Archive.

Jitter and WFPC2 Associations

ST-ECF embarked on a project aiming at grouping, cosmic-ray cleaning and drizzling images taken by WFPC2 (Wide Field Planetary Camera). Therefore, very precise pointing information is required. The jitter files proved to be the most reliable source of pointing information, with a relative accuracy between two exposures in the same HST visit of about 0.01 arcsec (A. Micol et al. in this issue, related web page \r * MERGEFORMAT [6]). Furthermore, possible pointing instabilities of HST during an observation can be assessed which are sometimes leading to evident perturbation of the PSF (Fig. 2).

ECF’s archive interface includes a Java applet that draws X/Y plots of any two columns of a jitter file as seen in Figure 2. This can be done interactively through a common web browser (M. Dolensky et al. in this issue [5]).

Since WFPC2 replaced WFPC in December 1993, it was necessary to

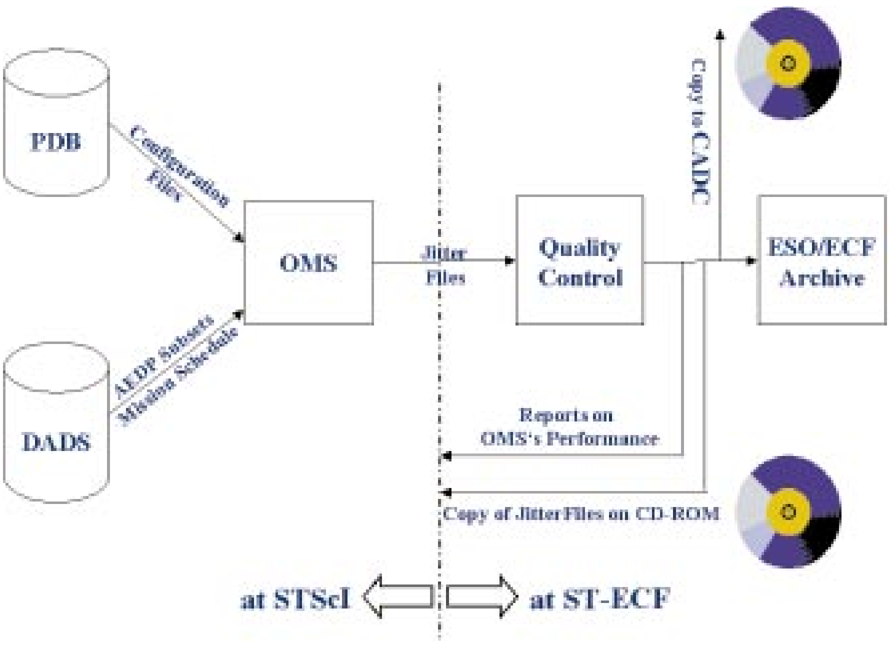

Figure 1: Jitter file generation pipeline remotely operated from ECF.

set up a pipeline at STScI to compute the missing jitter files for the time period December 1993 – October 1994. This pipeline (Fig. 1) was operated remotely from ECF and generated jitter files for additional 16,000 data sets of all HST instruments. The engineering telemetry came from the Data Archive and Distribution System (DADS) at STScI and the historical spacecraft configuration was reconstructed using the Project Database (PDB). The resulting jitter files were not only ingested into the ESO/ECF archive but were also shipped on CD-ROMs to the STScI and the Canadian Astronomical Data Center (CADC).

As a next step, the remote pipeline at STScI was enhanced, so that it is for the first time possible to compute the spacecraft jitter for the whole lifetime of HST in a homogeneous way.

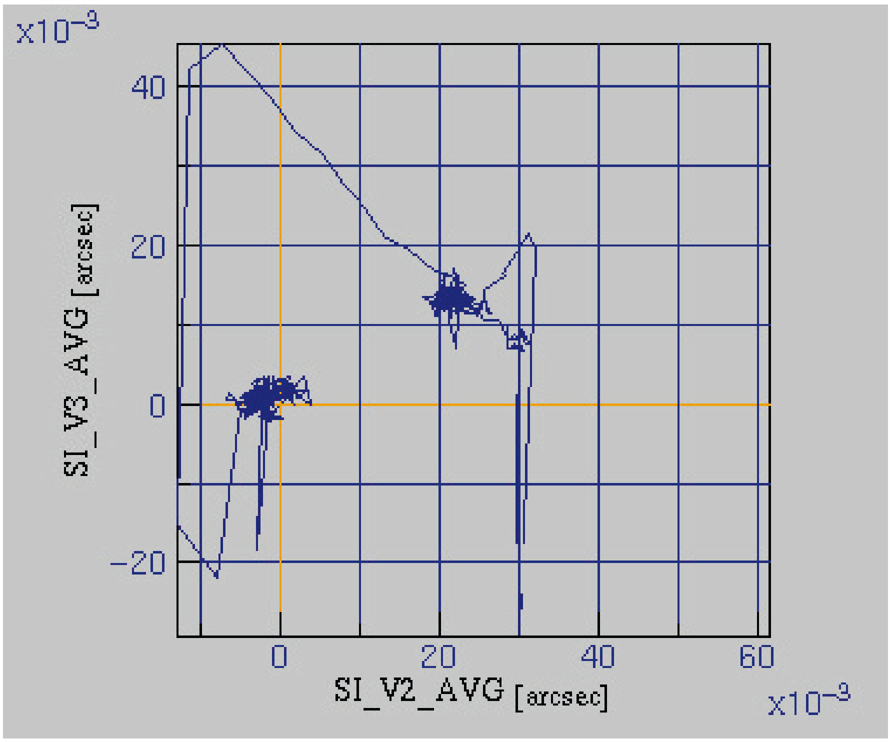

Figure 2: The plot shows how the telescope was moving relative to the guide stars during an exposure. For some reason, in the middle of this observation, HST's pointing moved by ∼25 marcsec, which corresponds to half a pixel of its planetary camera.

Engineering Telemetry and FOS Post Operational Archive

A different project that requires certain extra parameters of HST's engineering telemetry is the Faint Object Spectrometer (FOS) Post Operational Archive. Although FOS might be considered an oldie (it was replaced by STIS in February 1997) it's data are still precious and it will prove again the feasibility of the concept of predictive calibration that was jointly developed at ECF and ESO (M. Rosa).

There is, however, a small set of crucial input parameters missing for the recalibration, namely the magnetometer read outs of the on-board magnetometers. These magnetometer readings are required to estimate the particle-induced background count rate in the FOS digicons to scale geomagnetic shielding models. This became an issue, since there is a problem with the magnetic shielding of FOS, which was detected only after launch.

The solution was to prepare a software with the support of STScI that extracts the required telemetry values for the re-calibration. The extraction from the Astrometry and Engineering Data Processing (AEDP) subset files is currently done at ECF.

Outlook

In future, the Control Center System (CCS), currently developed at Goddard and STScI together with Lockheed, will include a data warehouse for direct access to historical telemetry. This will make it much easier to study the impact of certain parameters on scientific data.

Acknowledgements

The analysis of HST engineering telemetry was only possible with the invaluable help of the DP-, OPUS- and PDB-Teams at STScI. For his collaboration in the early stages of the project many thanks to J. Paul of MPE.

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ST-ECF Participation in the GSC-II Generation Project

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1. Background and Rationale for the GSC-II Project

There are a number of motivations for scanning and cataloguing photographic plates: first of all, the release of a 2-billion-object catalogue would generate uncountable science and mission-support projects which would be more than welcome for HST and future space missions as well as ground-based telescopes. The significance of this project has already been acknowledged with the formation of an international consortium to proceed with its construction with currently available resources. These partners include STScI, CRA (Osservatorio di Torino), ESO and GEMINI. Additional support for the digitisation of the plates (DSS-II) is also being received from ESO, CDS, CADC, NAOJ and the AAO.

The HST Advanced Camera (ACS), poised to be launched at the end of 1999, has in particular “bright” object avoidance scheduling constraints. The Space Telescope Science Institute is currently performing similar bright object checks for observations using the STIS MAMA detectors, but this is being done manually, and is laborious and time consuming. These could be greatly simplified and automated if a homogeneous, deep, complete catalogue down to magnitude 18 were available. Whilst the final requirements for the operation of the future HST COS (the selected Servicing Mission SM-4 replacement instrument scheduled for 2002) are still being determined, it is known that it has a small 2″ acquisition aperture which may be affected by the proper motion distribution of the guide stars. Hence the availability of guide star motions, or even the positions from the second epoch plates, can simplify the process and reduce the acquisition failure rate. The planned GSC-II would meet all these requirements but its currently scheduled delivery time of 12/2000 will not meet the current ACS launch constraint. We feel that the GSC-II is one essential component in reducing the operations cost of HST.

In order to expedite GSC-II availability, we have put together an action plan with extra resources contributed to the project so that a preliminary deep all-sky catalogue (without proper motions) can be completed around Q4 1999 to support bright-object protection checks.

2. Generation of the GSC-II

The generation of the GSC-II catalogue consists of a number of steps, simple in concept, but heavy in operational burden.

2.1 Scanning

2.1.1 Scan all 3576 plates from the second-generation Schmidt surveys

(POSS-II in the Northern Hemisphere and the AAO-SES in the south). The sampling is 15 micron (1 arcsec) which results in 23,000 pixel square raster images of 1.1 GB byte each. This represents almost 4 Terabytes of data in total. This first step has been done at the Space Telescope Science Institute and is now virtually complete. A lightly compressed version is now being distributed to a small set of selected sites, including ESO (Garching), where the scanned plates are available via the WWW: http://archive.eso.org/dss/dss

2.1.2 Combination of old and new plate scans

Combine with the first-generation survey plates that STScI has already scanned with a resolution of 25 microns (1.7 arcsec pixels) for the GSC-I and DSS-I projects. [Note that eventually STScI will re-scan some of these plates at 15 microns but this is of lower priority]. These 2390 plates represent another 1TB of data.

2.1.3 Scan old plates

Scan at lower priority the 894 POSS-I O plates that were not used in the GSC-I project.

2.2 Plate Processing

The second step involves a pipeline processing on single digitised plates where object detection (with de-blending) and preliminary calibration is taking place on-line. Results are stored in an object-oriented database management system which will reside on an HSM (Hierarchical Storage Management) controlled mass-storage system. Quality control happens throughout this phase as well. This is the most resource intensive part of the production work: The massive amounts of scan data are retrieved from the CASB image archive, processed extensively and the results saved and loaded into the COMPASS database. Estimates for the size of the database range from 4 to 8TB.

2.3 Catalogue Construction

2.3.1 Analysis of the calibrated object parameters

This step involves an analysis of the calibrated object parameters in the database to quantify the systematic errors and to recalibrate the derived parameters without a major reprocessing of the original scan data.

2.3.2 Export Catalogue

Derive exported catalogue from the large object database after merging overlapping plates and plates of the same field but of different colours. The new export catalogue will be compatible with the ESO SKYCAT interface (see http://www.archive.org/ skycat), and many other (web) interfaces can be expected to be available to retrieve catalogue data. The storage possibilities of a large table have been examined in [Wicenec 1996].

3. Participation of the ST-ECF

The ST-ECF has extensive experience in manipulating and processing large volumes of scientific data. It has strong connections with the STScI thanks to its HST support mandate in Europe. In addition, the location of the group inside ESO (another patron of the GSC-II project) as well as its proximity to the other European partner has motivated the ST-ECF to provide direct help to the existing collaboration.

At this stage in the project, the software development is essentially over. Production has already started in March. The best use of ST-ECF resources is to assist with the operation of the massive pipeline processing in order to accelerate the availability of the data for HST operations after Servicing Mission 3.

3.1 Interfaces

The geographical separation of the three sites where processing is taking place (STScI, ST-ECF and Osservatorio di Torino) implies the definition of reliable data transfer interfaces. The volume of data involved immediately rules out any on-line electronic data transfer of the image data using such means as FTP. Therefore, airmail shipment of media with the actual data to be processed and their results has been organised.

Procedures for problem reporting and bug fixes have been set up in such a way that the pipeline does not stay idle for long periods of time. Proper training of the operation and quality control staff took place.

3.2 Resources required

In order to meet the target date for a preliminary single-epoch catalogue by HST SM-3, it is necessary to approximately double the plate-processing rate that STScI had previously planned. This implies that ST-ECF has effectively duplicated the hardware and manpower that STScI currently has dedicated to the operation of the plate pipeline.

If the above production rate can be sustained, it means a nominal production time of about one year. To this, a large amount of time for manual re-processing of plates failing the processing step for one reason or another and extra quality control/bug fixes has to be added.

The pipeline software currently runs on DEC Alpha Open VMS systems and is composed of C, C++, FORTRAN and IDL code. Therefore, the ST-ECF has acquired an up-to-date DEC Alpha server 1200 with 2 × 500 MHz processors, 1 GB of memory and about 100 GB of disk space. A large amount of cassettes for the data transfer has also been acquired.

Operating the pipeline requires manpower to do operations such as loading the plate tapes into readers, write the output on media but also – and more importantly – perform quality control of the object extraction results. The quality control flags bad/doubtful plates, which are forwarded to the science team in Torino for investigation. For this resource, two full-time employees have joined the ST-ECF archive for two years (Nathalie Fourniol, previously in Strasbourg and Roberto Mignani formerly at the Max- Plank Institut für Extraterrestrische Physik).

4. Conclusion

In being involved in the GSC-II project, the ST-ECF is actively taking part in one of the major astronomy achievements of the decade. In a two-year effort, our contribution will bring a more timely delivery of the (first version) of an all-sky, 2-billion-object catalogue complete to beyond magnitude 18, available just in time for the next millennium.

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HST Archive Services Implemented in Java

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Abstract

In order to facilitate archive data selection and basic data analysis, a number of Java Applets only requiring a common web browser are now complementing the HST Archive [3].

This article discusses various applets which are already part of the archive web interface. These applets display and manipulate FITS images as well as spectra taken with HST. A generic plot utility is also used to present a set of pointing and specialised engineering data, called jitter files [4].

Spectral

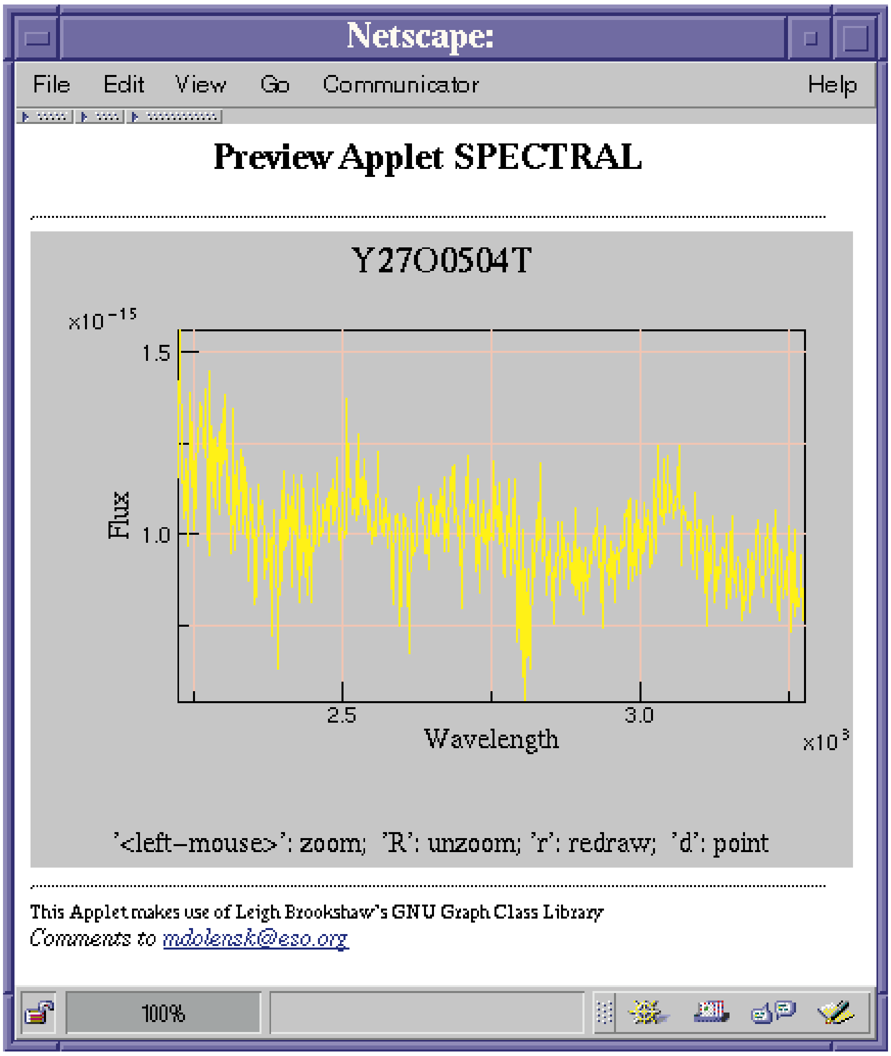
This applet is a previewer for HST spectra. It is integrated into the WDB web interface (Fig. 1) and offers various options to inspect spectra with the mouse and by means of hotkeys. The screenshots in this paper show, that a standard web browser like Netscape 3 or Internet Explorer 3 is sufficient to run this applet. Micol et al. (1996) [1] discussed this issue in more detail.

Java Image Preview Application (JIPA)

While Spectral presents plots of spectra, JIPA's task is to visualise FITS images, i.e. HST preview image collection, and to allow basic image manipulation. The input data format is compressed FITS. There are several options for contrast enhancement, zooming and displaying header keywords (Fig. 2). Another feature is the conversion of mouse locations from pixel space to RA and Dec. JIPA is written in pure Java like the other applets presented in this article and therefore platform independent.

JPlot

JPlot was developed to support the WFPC2 Association Project [2]. It's original task is quality control of HST observation log files (= jitter files). In the meantime it became an integral part of the web interface. It visualises ASCII tables and

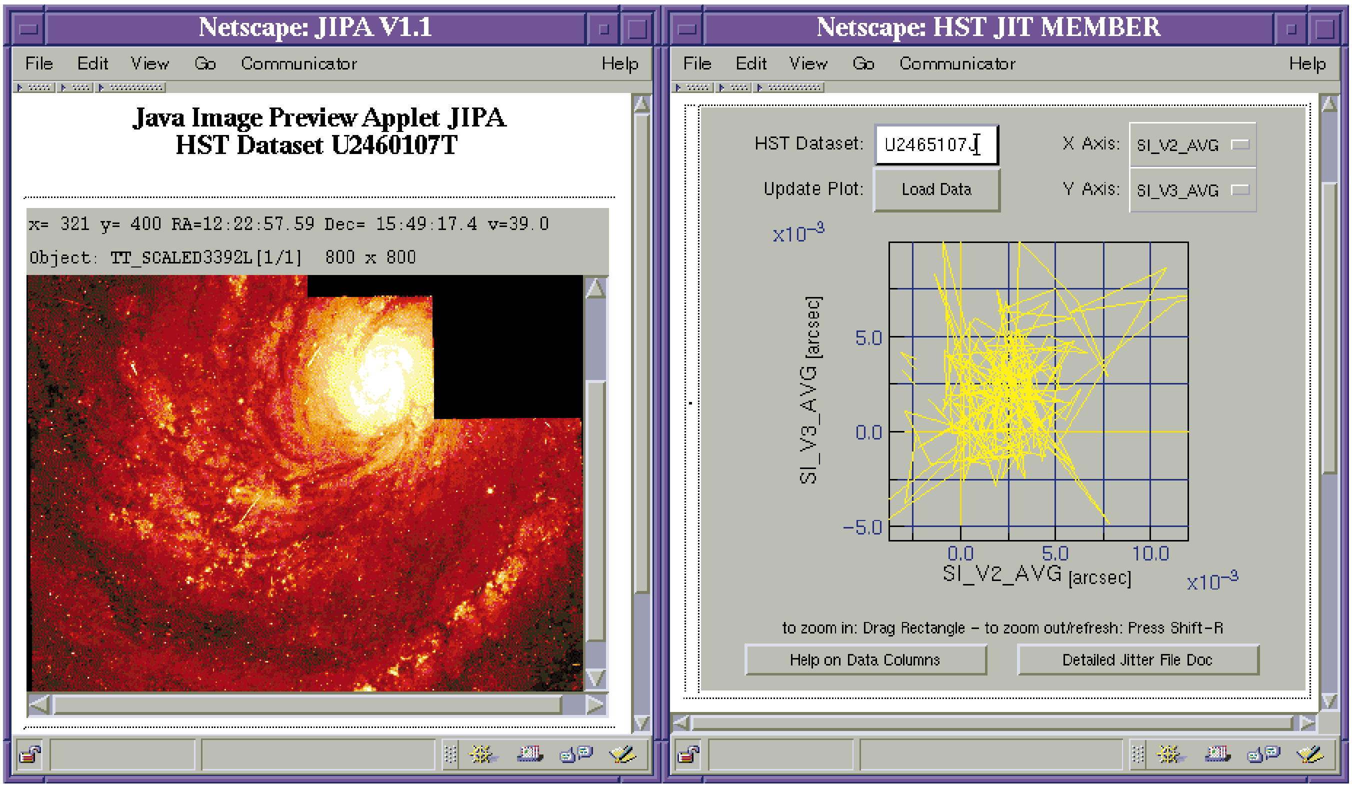


Preview Applet SPECTRAL

'<left–mouse>': zoom; 'R': unzoom; 'r': redraw; 'd': point

This Applet makes use of Leigh Brookshaw's GNU Graph Class Library
Comments to mdolensk@eso.org

Figure 1.



Java Image Preview Applet JIPA
HST Dataset U2460107T

x= 321 y= 400 RA=12:22:57.59 Dec= 15:49:17.4 v=39.0
Object: TT_SCALED3392L[1/1] 800 x 800

HST Dataset: U2465107J
Update Plot: Load Data
X Axis: SI_V2_AVG
Y Axis: SI_V3_AVG

to zoom in: Drag Rectangle – to zoom out/refresh: Press Shift-R

Figure 2.

displays them interactively as X/Y plots (Fig. 2).

The rather complicated back-end of this utility retrieves a FITS table from the archive, extracts the requested columns using IRAF and puts them into a cache area. The cache provides accelerated access when the same information is requested repeatedly by web users within 24 hours.

Outlook

Activities in the near future will include:

- JDBC interface to SQL server (replacing CGI scripts)
- collaboration with STScI in the field of enhanced web interface
- adding advanced features to overcome browser incompatibilities, like automatic updates

Acknowledgements

The initial implementation of JIPA was done by contractor E.C. Downey. A number of features were added later on by ECF staff.

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HST Archive News: On the Fly Recalibration (OTF) of NICMOS and STIS Data

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Introduction

HST science data are automatically calibrated when they are received at STScI (Space Telescope Science Institute) and these calibrated data are included in Baltimore's archive. The calibration software, which is contained in the IRAF/STSDAS hst_calib package, takes as input the raw data and any necessary calibration reference images or tables if they are already available [2]. The software determines which calibration steps to perform by checking the values of the calibration switches in the header. It selects which reference files to use in the calibration by examining the reference file keywords. The values of these switches and keywords depend upon the exact configuration of the instrument, the date of the observation and any other constraints. The values are set in the headers of the raw data in OPUS (OSS-PODPS Unify System).

Until the end of 1995, when users requested calibrated data from the HST archive, they received the data produced by the OPUS pipeline. However, with instrumental properties changing with time, better approaches for calibration of some instruments have been introduced and there have been other general improvements to the calibration of HST data. So what is a user to do? Fortunately, the same, or improved, software that runs in the calibration pipeline at STScI is also available in the released version of IRAF/STSDAS. One can recalibrate data from the archive by starting with the raw data, editing the appropriate header keywords to reflect the new calibration files and running the appropriate software. The STScI maintains a database that contains the recommended calibration reference files for each observation. However, this is not the most convenient approach for users, and this led us to develop an automatic recalibration process for HST data that essentially duplicates what a user would do manually. The on-the-fly re-calibration of the first generation of HST instruments was developed and introduced in the CADC and ST-ECF archive at the end of 1995 [1].

Implementation

In 1997, two new instruments were put on board of HST. During the last year, CADC and ST-ECF worked together on the extension of the OTF calibration pipeline to support NICMOS and STIS. The long developing period is due to the fact that the initial life of a new instrument is always somewhat difficult due to teething problems: instrument description keywords are found to be missing, or wrongly populated, the calibration software must be revised to consider changes in the instrument responses compared to the ground tests, calibration reference files are not immediately available, etc. All those stabilisation problems led us to actually offer the OTF pipeline only about 1 year after the Servicing Mission.

A decision was taken to not rely on the header of the files, but instead to retrieve the calibration keywords form the HST database. While the keywords in the files cannot change anymore, the HST database can be kept up-to-date and keywords values corrected. Therefore the OTF pipeline for NICMOS and STIS is completely database driven.

The OTF calibration pipeline steps for a science observation are the following:

1. getting raw data from CDs (stored in a compressed form)
2. getting latest database information on relevant keywords (new/updates)
3. getting latest database information on relevant calibration files (new/updates)
4. setting the proper calibration switches relevant to the observation mode for a specific instrument
5. update the header of the science file
6. apply calibration software (STSDAS)

As already mentioned some pre-requisites are necessary:

1. Database updates
2. Calibration file updates
3. Software updates

A SYBASE replication server keeps the CADC and ST-ECF HST database copies identical to the STScI one in real time; the calibration reference files are kept up to date via a retrieval that takes place on a daily basis by CADC, via a Starview request, and are then “pushed” to ST-ECF.

Particularities

While building the OTF pipeline, we had to deal with some aspects which are particular to the new instruments and which originate from some choices made by the IDTs (Instrument Dedicated Team) in the designing phase of the instruments data products. Multiple extension FITS files were introduced, and we had to wait for a stabilised release of a new version of IRAF (v 2.11) to be able to manipulate the new file types. The STSDAS calibration software (calnica, calnicb and calstis) evolved rapidly and is still changing. Some STIS observing modes are not yet completely covered by the calibration software. STIS and NICMOS association concepts differ, introducing therefore asymmetry in the development of the pipelines.

Conclusions

The OTF system contributed (and still contributes) to the reliability of the calibration software: we found and reported problems to the STScI/STSDAS group, which quickly fixed them. As soon as a new version of the calibration software is released, we install it in our pipeline. Our archive users, with their archival requests, also contribute to extensively test the software. The OTF pipeline is used at CADC to produce NICMOS and STIS preview images/spectra of all the available datasets (15 minutes after release date), further contributing in testing the pipeline.

In other words, the OTF pipeline, being in a never-ending development phase and continuously receiving new reference files, is a lively system. An observation calibrated two months ago is different from the one calibrated today. Only at the end of the life of an instrument, when the “final archive” is produced (i.e. no further development is foreseen), will this process stop and the best (?) calibration pipeline be available to the community.

At the time of writing, the HST archive is composed of 269 CDs for the RAW data (as of July 1st, 1998), and has 18 GBytes of calibration files.

The HST OTF service is available at:
http://archive.eso.org/archive/hst/ at ST-ECF (catalog@eso.org)
http://cadcwww.hia.nrc.ca/hst/ at CADC (cadc@hia.nrc.ca)

The ESO OTF service is foreseen; sometime in the future, also NTT and VLT archive users will benefit by this indispensable archive tool.

Acknowledgements

All this work has been made possible thanks to the help of the STScI/STSDAS team, and especially of Phil Hodge and Howard Bushouse.

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HST Archive News: WFPC2 Associations

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Astronomers having browsed/visited the HST archive in the last six months have encountered a new type of WFPC2 dataset: the Association. This is the materialisation of a new service offered to ST-ECF archive researchers, meant to reconstruct the otherwise missing knowledge of the observing strategy (expected CR-SPLIT, expected dithering) adopted by a WFPC2 PI. Unlike NICMOS and STIS, where a dataset might be constituted of a set of exposures, the WFPC2 dataset’s structure was thought to be a repository of all the files belonging to a single exposure. Building associations of WFPC2 exposures is therefore to be considered an important step towards a comprehensive description of the HST archive contents. The association concept alleviates the need to discover:

- which observations can be grouped together in order to run a cosmic-ray cleaning algorithm;
- how a set of WFPC2 images map the region around an astronomical source of interest.

To achieve this goal of re-constructing the observing strategy of the PI, it is necessary to find out the exact displacement between any two exposures. There are two methods to compute the displacements among the images: by using the World Co-ordinate System (WCS) keywords normally stored in the header of the dataset, or via a cross-correlation technique. For WFPC2 exposures (more than 35,000 when writing this article), a number of problems arose while considering those two approaches:

- Before April 1996 the WCS keywords in the dataset fits header were not reflecting dithering strategy; even after that date, the WCS keywords are computed using phase two proposal information, that is, WCS values do not take into consideration what happened during the observation.
- Cross correlation of exposures would be difficult due to the presence of cosmic rays and depends on the signal-to-noise ratio of the features in the images.

These problems led to the impossibility to use any of those two methods in an automatic pipeline. Instead, to compute the offsets among all the exposures in the association, we decided to use the pointing information stored in the HST observation log files [2], informally called “jitter files”.

The jitter files have proven to be by far more reliable than any other available source of pointing information [1]. Some keywords (GUIDEACT, LOCKLOSS, SLEWING, etc.) in the jitter files along with the standard deviations of the measurements (right ascension, declination, roll angle) are used to evaluate the pointing stability during the observation and the accuracy of the measurements [3].

Once the offsets (in right ascension and declination) are computed, it is easy to derive the shifts expressed in pixels via the knowledge of the spacecraft orientation (roll angle) and of the focal plane geometry through the Science Instrument Aperture File (siaf).

A WFPC2 association containing all the WFPC2 exposures of the requested region of the sky, belonging to the same proposal, taken in the same filter, having the same position angle, can hence be seen as the ultimate repository of the observing strategy (real CR-SPLIT, real POS-TARG) as attained by the telescope.

Via the web (http://archive.eso.org/wdb/wdb/hst/science/form) users browse through the associations, have a closer look at a specific association, and immediately see what are the shifts among the exposures belonging to it.

Furthermore, an astronomer interested in that association can issue a request and ask our archive system to not only re-calibrate each exposure in the association, but also to combine them (if the offsets do not exceed the imposed limit of 5 mas beyond which the PSF of the combined images is degraded) to get cosmic-ray-free products. All the steps of the association pipeline are documented in log files that can be retrieved along with all the other products.

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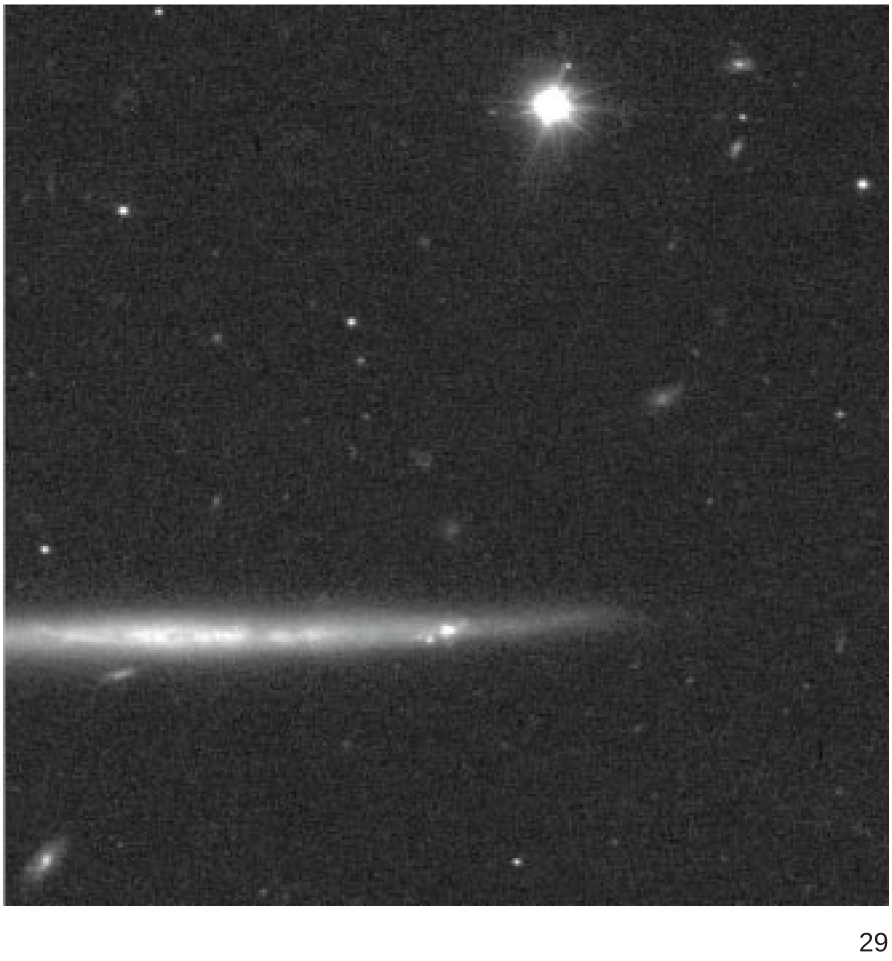
Image from the VLT Science Verification Programme



The galaxy ESO342-G017 was observed on August 19, 1998 during a spell of excellent observing conditions. Two exposures, each lasting 120 seconds, were taken through a red filter to produce this photo. The quality of the original images is excellent, with FWHM of only 0.26 arcsec measured on the stars in the frame. The frames were flat-fielded and cleaned for cosmics before combination.
ESO342-G017 is an Sc-type spiral galaxy seen edge-on, and the Test Camera was rotated so that the disk of the galaxy appears horizontal in the figure. Thanks to the image quality, the photo shows much detail in the rather flat disk, including a very thin, obscuring dust band and some brighter knots, most probably star-forming regions. This galaxy is located well outside the Milky Way band in the southern constellation of Sagittarius. Its distance is about 400 million light-years (recession velocity about 7,700 km/sec). A number of more distant galaxies are seen in the background on this short exposure.
The field shown measures ~ 1.5 × 1.5 arcmin. North is inclined 38° clockwise from the top, east is to the left.

(Figure and caption are from the ESO web pages at http://www.eso.org/outreach/press-rel/pr-1998/pr-12-98.html *prepared by the ESO Education and Public Relations Department.)*

VST: VLT Survey Telescope

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1. Introduction: VST Scientific Framework

The VLT era is rapidly approaching: the first instruments, ISAAC and FORS at UT1, will be available by the year 1999. Indeed, the beginning of the new millennium will witness fierce competition among quite a few 8-m telescopes, operated by different groups. As a consequence, there is a strong need to prepare, in a timely manner, suitable target-lists for the VLT, in order for it to play the leading role in ground-based optical and IR astronomy in the next decade. Preparation is one of the keys to success for the VLT observations.

The VLT will work at flux levels for which no whole-sky surveys are available, and most of the currently submitted science cases (SC) will not be feasible without major preparatory work (Renzini & Leibundgut, 1997, *The Messenger* 87, 21; Da Costa et al., 1997, *The Messenger* 91, 49). The SC target selections are based on extensions of current data sets. Only a few spectroscopic or high imaging projects at the VLT will plan to build their own catalogues directly from VLT imaging data. In conclusion, the exploitation of the VLT requires catalogues of objects and supporting observations obtained at other – smaller – telescopes. As an example, multi-object spectroscopy depends on very accurate target positions which must be provided in advance of the actual VLT observations (to set up slitlet arrays for FORS or provide masks for VIMOS and NIRMOS).

The need to find faint or rare but interesting objects to study with the VLT in statistically significant quantities has urged ESO to start the multi-band ESO imaging survey (EIS; Renzini & Da Costa, 1997, *The Messenger* 87, 23), and many other observatories are building up large field-of-view instruments (e.g. the SLOAN project). However, EIS is meant to supply targets only for the near future, but certainly cannot sustain the needs of the ESO community which will be using the VLT for top-level science during the several years to come.

Over the years, broad- and narrow-band wide-field imaging (WFI) has provided the astronomical community with a wealth of data, which has been of great importance in many different fields in astrophysics and cosmology. WFI with 2-metre-class telescopes has been, up to now, the key instrument to produce statistically-controlled target-samples to be studied both photometrically and spectroscopically with 4-m telescopes. The advent of 8-metre-class telescopes requires extensions of WFI down to much fainter magnitudes which are out of reach of photographic material. Planned CCD WFI surveys (such as the SLOAN DSS) will push the magnitude limit down to R_{AB} = 23, but so far they are restricted to the northern sky only.

The above arguments justify the compelling need for a dedicated medium-size telescope with a wide-field imaging capability in the southern hemisphere. This need motivated the proposal to ESO by the Capodimonte Astronomical Observatory (OAC) at Napoli to build the VST (= VLT Survey Telescope) and place it at Paranal.

The VST is meant to be a highly efficient telescope; it will reach a magnitude limit of $R = 25$ AB mag arcsec^{-2} in 3 × 10 min exposures over a field of 1 deg^2, with an instrumental resolution of 0.21″. The scope of this facility is to supply complete databases for VLT science, and possibly to produce new science from the WFI data alone. Because of its complementary use to the VLT and for an obvious integration in the VLT operating system, it shall run with the same software and be a fully dedicated instrument for multi-band optical imaging.

The VST may be relevant for a number of topics such as those listed hereafter (the list is by no means complete):

(i) Distant objects: quasars, high-z galaxies, clusters of galaxies, supernovae, lensed objects, absorption systems, weak lensing;

(ii) Nearby galaxies: globular clusters, HII regions, planetary nebulae, novae, emission-line stars;

(iii) The Galaxy: the items from (ii) plus subdwarfs, white and brown dwarfs, metal and very rich/poor stars, and microlensing towards the Galactic bulge for statistics on the presence of earth-like planets;

(iv) Optical identifications: the VST will provide optical identifications of objects found at other wavelengths, such as X-rays, IR, microwave and radio continuum sources.

Once the above galactic and extragalactic targets are identified via the VST, they will require further imaging (at different bands and angular resolution) plus low- and high-resolution multi-object spectroscopy (both in the visual and IR) available at FORS1/2, ISAAC, CONICA, VISIR, UVES, VIRMOS. In particular the VST will constitute an essential tool for the construction of surveys.

Therefore, the strong advantages of the VST project in the VLT era are:

1. a wide-field imaging project fully conceived for and devoted to VLT science. Its task will be to provide the preparatory data for the follow-up observations with VLT;
2. a wavelength range from UV to I with high efficiency in the UV;
3. a minimum of additional optics combined with a high DQE detector;
4. the exploitation of the outstanding photometric and seeing characteristics of the Paranal site;
5. the high efficiency in both calibrations and data reduction in view of the complete dedication of the telescope to imaging with a single instrument.

In this paper we describe the history of the project, and the telescope concept. This project is then compared to existing or planned WFI facilities. For a detailed description of the science case with the VST we refer to the “VST proposal”, available upon request at the OAC.

2. History of the Project

Given the scientific framework and the need for such a facility, the OAC Director, M. Capaccioli, planned to engage the Napoli Observatory in the realisation of

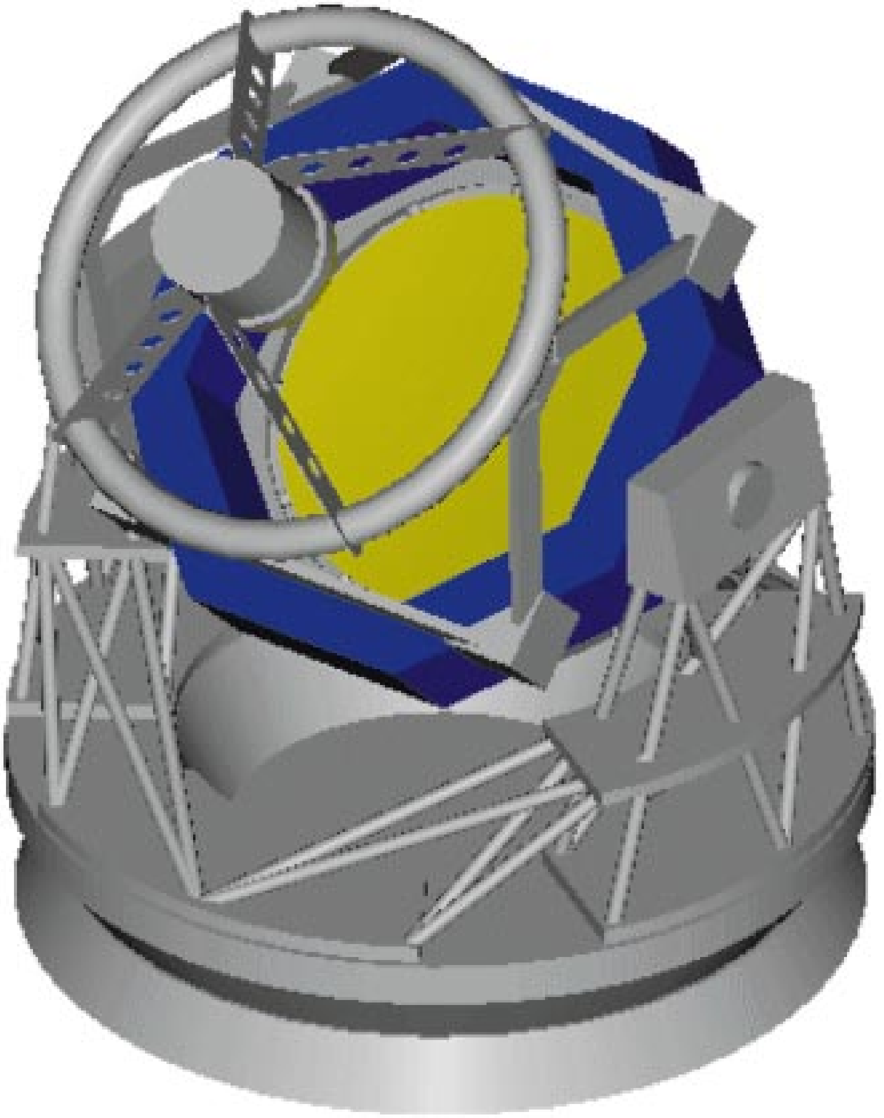

Figure 1: CAD 3-D view of the VLT Survey telescope.

a 2.6-m telescope for wide-field imaging and complementary use to the VLT. For this purpose the Observatory Council decided to allocate 6.5 billion Italian lire of *ad-hoc* funds assigned to OAC by the Ministry of University and Research as part of the programme of developing depressed areas in the south of the country by financing cultural activities and existing centres of excellence in science and technology. This resolution rested also on the consideration that OAC has some background in astronomical instrumentation, given its collaborations with ESO and other European institutions in the VIRMOS project, and its contributions to the TNG, the Italian 3.5-m National telescope, just to name two of its partnerships in international projects. Through its Technology Working Group (TWG) managed by D. Mancini, OAC has also designed and built its first telescope, an alt-azimuthal 1.5-m aperture instrument named TT1 (Toppo Telescope No. 1), which is now waiting for the transportation at Toppo di Castelgrande (Potenza), the former domestic site of the TNG; it should be operational by the end of the current year. Furthermore, science-wise its research staff has a strong interest and a well-established background in surface photometry and wide-field imaging.

In March 1997, the OAC Director appointed a Scientific Steering Committee, chaired by G. Vettolani, to study the case for a 2.6-m WFI telescope, to be proposed to ESO for installation at the Paranal Observatory (Chile). The Committee prepared the proposal with the scientific goals, which were used by D. Mancini and the OAC TWG to develop a preliminary study for the optical, mechanical, and electronic specifications of a 2.6-m telescope with a 1 square degree field-of-view (FOV). The combined scientific and technical proposals were submitted to ESO on June 17, 1997. The project was presented to the Director General of ESO, R. Giacconi, and to the heads of ESO divisions on July 29, 1997. The scientific case and the technical proposal were then revised to incorporate all of the ESO suggestions. It was also agreed to change the project name from the former TT2 (Toppo Telescope No. 2) to VST. During this initial phase of the project, the ESO contact point was S. D'Odorico. The final VST proposal was reviewed by the ESO Scientific and Technical Committee (ESO/STC – 219 document) at the occasion of its 44th Meeting in October 1997. The STC expressed strong support for the project, assigning it a high priority. The VST Memorandum of Understanding between OAC and ESO was submitted to the ESO Council for approval on the 11th–12th of June 1998, and the official kick-off of the project was held during a meeting at ESO on the 24th–25th of June 1998. The OAC will be responsible for the design, construction, and commissioning of the VST, and the OAC will provide up to two astronomers for the support of the VST operation starting in 2000. ESO will be in charge of the design and realisation of the enclosure and its control system plus civil works at the Paranal site and of providing a camera adequate to fulfil the goals of the project.

On March 1998, Zeiss Jena was awarded the realisation of the VST optics; the contract with Zeiss was signed by the end of May and the final optical design agreed by ESO and OAC was forwarded to Zeiss at the end of July. On April the 4th, 1998, ESO issued a call for tender for the realisation of the 16k × 16k CCD camera to be placed at the Cassegrain focus of the VST.

The OAC Council has appointed G. Sedmak, from the University of Trieste, as Project Manager for the realisation phase of the VST and D. Mancini as Deputy Project Manager. The VST Manager on the ESO side will be R.J. Kurz, and the Deputy Manager S. D'Odorico. An Advisory Board will monitor the progress and give inputs to the Project Manager: the Chairman of this Committee is M. Capaccioli, the Co-chairmen are P. Rafanelli and P. Vettolani. The experts are P. Dierickx, K. Freeman, and D. Hamilton. The VST Project Scientist is M. Arnaboldi, and the Chairman for the VST Science Group is R. Scaramella.

3. VST Technical Overview

3.1. The project philosophy

The scientific goals for the VST project can be summarised as follows: a fully dedicated instrument with an excellent image quality on a large FOV, high operational efficiency, high reliability, and compliance with VLT standards. Therefore the project guidelines are:

- Optimisation of the whole system for the global-system cost-optimisation.
- Extended use of finite element analysis, which optimises the structure costs and performances.
- The use of the system just as a survey telescope will make it possible to simplify the overall project during the final design phase.

- The OAC TWG will construct in house part of the telescope subsystems. This will make it possible to achieve a better steady-state mean-time-to-reparation (MTTR), given the knowledge of the system by the TWG team.

3.2. The telescope concept

The VLT Survey Telescope is a 2.6-m telescope, designed for Cassegrain operations, with a corrected FOV diameter of 1.5 degree, to be matched with a 16k × 16k CCD mosaic camera, with a 15 μm pixel. The telescope has an Alt-Az mounting, which allows a high mechanical stiffness and a compact overall structure: a 3-D view is shown in Figure 1. The structure will be an open frame with tubular components in order to increase the stiffness vs. weight ratio and to simplify any installation procedures. The wide-field corrector is designed to cover the whole visual wavelength range, from U to I with an encircled energy of 80% in a 1.7 pixel or better. Following the kick-off meeting at ESO, the corrector design in the VST proposal was revised: the new corrector design foresees the use of two lenses plus a curved dewar window when observing near zenith, and this configuration can be replaced by one lens plus an ADC, when observing in the B to I bands at large zenithal distances. The primary and secondary mirrors will be active and controlled by means of a Shack-Hartman wavefront sensor; the optical scheme of the VST is shown in Figure 2, and Figure 3 shows the encircled energy diagram for the U band in different regions of the focal plane.

The telescope enclosure will be designed in collaboration with ESO. The design takes into account the use of an air-conditioning system to control the temperature of the telescope during the day. The final design of the enclosure will be compliant with a number of nights lost due to wind of about 10% during a year of operation, based on the wind statistics of the Paranal site.

The VST telescope control architecture follows the concepts developed for the VLT by ESO; in doing so, the system coherence is increased, an easier maintenance programme is possible, and the integration into the existing ESO hardware and software environments is ensured. The basic idea is to maximise the use of VLT standards and software, whenever it is possible and convenient.

4. How Does VST Compare with Other WFI Facilities World-wide?

Tables 1–5 provide an exhaustive summary of existing and planned (within a 3-year period) WFI facilities. Table 1 provides a summary of the non-ESO WFI facilities; Table 2 deals with the WFI ESO facilities, and Tables 3 and 4 contain details on planned multi-colour surveys. The last line of Table 3, 4 and 5 reports the values for the VST facility according to the current status of the project.

4.1. Why the Paranal site?

Such a point is crucial in addressing the efficiency of the VST telescope with respect to existing or planned WFI facilities world-wide. The Paranal site has the best uncorrected seeing (0.4″; median seeing 0.65″) in the southern hemisphere and a very high percentage of photometric nights (77%). We can quantify a 35% gain for the percentage of photometric nights, and a 36% gain in the better median seeing (0.65″) of Paranal vs. La Silla (0.87″) which result in an "environmental gain" in efficiency of the Paranal site with respect to La Silla of a factor 2.35. If we consider the "environmental gain" of the Paranal site for the winter season (ideal for the Galactic bulge studies), this becomes a factor 3 from the higher percentage of photometric nights at Paranal during this season. The choice of the Paranal site for the VST will make such a telescope one of the most competitive dedicated WFI facilities in the world, as is clear from the following direct comparison with existing ESO and non-ESO facilities.

4.2 Comparison with non-ESO WFI facilities

From Table 1, in the southern hemisphere, neither existing (UKST, CTIO) nor planned (AAT, GEMINI) WFI facilities can compete with the VST project when we consider scientific programmes aiming at surveying several hundred square de-

TABLE 1. Summary of non-ESO WFI facilities

Name (1)	Aperture (2)	Inst. (3)	Focus (4)	FOV (5)	Mpix (6)	Scale (7)	Year (8)	% (9)	Seeing (10)	Country (11)
NOAO	0.9	16 CCDs	PF	1	67	0.43″	1997	20	1″	USA
ING	2.5	4 CCDs	PF	0.16	16	0.37″	1997	25	0.75″	NL-UK-E
NOAO	4	16 CCDs	PF	0.36	67	0.27″	1997	20	1″	USA
WHT	4	1 CCD	Cass.	0.025	1	0.6″	1997	20	0.75″	NL-UK-E
du Pont	2.5	WFC	Cass.	0.137	4	0.75″	1997	25	0.8″	USA
UH	2.2	8kCCDs	F/10	0.67	67	0.13″	1997	30	0.63	USA
Laval	2.7	CCD	PF	0.5	4	0.6″	1997	100	1″	CAN
Univ.	5.1	CCD	PF				1997	100	1″	CAN
APO	3.5	DSCCD			4	0.141″	1997	20	13	USA
Subaru	8.3	Suprime Cam	PF	0.136	80	0.18″	1999	15	0.6″	Japan
CFHT	3.6	MEGA CAM	Cass.	1	288	0.21″	1999	20	0.6″	France-CAN
Sloan	2.5	30 CCDs	Cass.	9	126	0.4″	2000	100	1″	USA
MMT	6.5	MEGA CAM	Cass.	1	268	0.22″	2000	20	0.8″	USA
Keck II	10	DEIMOS	Nashm.	0.045	134	0.12″		17	0.55″	USA
C.Alto	3.5	WFNIR Omega	PF	0.01	1	0.4″	1997	30	1″	D-E
CTIO	4	4 CCDs	PF	0.25	16	0.4″	1996	15	0.9″	USA-Othr.
UKST	1.2	Plates	Schmidt	43		67″/mm	1997	100	1.6″	UK-AUS
AAT	3.9	CCD	PF	0.02	4	0.367″	1998	30	1.6″	UK-AUS
Gemini	8	CCDs	Cass.	0.56			2000	25	0.25″	UK-USA-CAN-Othr.

Column (1) conventional name of the telescope; Column (2) size of the primary mirror in metre or equivalent diameter in case of multiple telescopes; Column (3) type (CCDs or photographic plates) and name of the instrument for wide-field imaging; Column (4) focus where the instrument is placed; Column (5) FOV in square degree; Column (6) number of pixels in Mpixels; Column (7) scale in arcsec pixel^{-1}; Column (8) expected year of completion; Column (9) fraction of time available for wide-field imaging, based on normal use; Column (10) average seeing at site; with AO, the seeing of Gemini is predicted to be 0.25″ in the wavelength range 0.5–0.9 nm. Column (11) countries.

TABLE 2. Summary of ESO WFI facilities

Name (1)	Aperture (2)	Instr. (3)	Focus (4)	FOV (5)	Mpix (6)	Scale (7)	Year (8)	% (9)	Seeing (10)	η (11)
DENIS I	1	CCD	Cass	0.04	1	1″	1997	50	0.9″	0.015
ESO 2.2 m	2.2	8 CCDs	Cass.	0.3	67	0.24″	1998	75	0.9″	1.125
DENIS J, K	1	CCD	Cass.	0.04	0.06	3″	1998	50	0.9″	0.015
VST	2.6	32 CCDs	Cass.	1	256	0.21″	2001	100	0.7″	13.6

Column (1) conventional name of the telescope; Column (2) size of the primary mirror in metres; Column (3) type (CCDs or photographic plates); Column (4) focus where the instrument is placed; Column (5) FOV in square degrees; Column (6) number of pixels in Megapixels; Column (7) scale in arcsec pixels; Column (8) expected year of completion; Column (9) fraction of time available for WFI, based on normal use; Column (10) average seeing at site; Column (11) survey figure of merit; see eq. 1

grees on the sky. None of these southern facilities is conceived as a fully dedicated telescope for wide-field imaging: all of them suffer either from a small FOV, large pixel-size, poor seeing, or a small fraction of allocated observing time. In comparison with these non-ESO telescopes (see Table 1), one sees that VST has the largest FOV (1 deg^2), with adequate spatial sampling, the best uncorrected seeing (0.4″) in the southern hemisphere, and the largest fraction of time available (100%) for WFI.

Tables 2 and 4 provide, among other parameters, the survey figure of merit η defined as

$$\eta = \Omega \times D^2 \times DQE \times (seeing)^{-2} \times \Delta T \quad (1)$$

where Ω is the area of the detector in deg^2, D is the diameter of the primary mirror, DQE is the quantum efficiency of the detector in the R band for the visible or in K for the NIR, and ΔT is the fraction of the time available for WFI, based on normal use during a year. For the VST, the value of figure of merit, calculated for $\Omega = 1$ deg^2, $D = 2.6$ m, $DQE = 0.85\%$, $\Delta T = 1$ and a mean seeing value $FWHM = 0.65''$, is η (VST) = 13.59. Only two other projects have comparable survey figures of merit: MEGACAM and SLOAN, which are both located in the northern hemisphere. The former project has a η = 5.76 because of a larger mirror diameter (4 m), but only a fraction of the CFHT observing time[1] will be devoted to WFI, while 100% of the time will be available for WFI at the VST. The SLOAN project has a higher η (= 22.5) because of its large FOV (9 deg^2) with respect to the VST. Such a facility will be entirely devoted to a sky survey and its spectroscopic follow up, without the flexibility which is needed for a variety of VLT preparatory works (choice of different areas in the sky, limiting magnitudes and broad bands).

When considering large sky areas, all other ESO and non-ESO southern telescopes have survey figures of merit which are smaller by at least an order of magnitude than that of the VST.

4.3. Comparison with ESO WFI facilities

Table 5 shows that the only ESO facility competing with the VST is the 2.2-m telescope when it is equipped with a focal reducer and a 8k × 8k CCD mosaic camera. Therefore, the VST telescope is a competitive facility only if it produces a major increase in the telescope efficiency for WFI with respect to the ESO 2.2-m telescope.

We have addressed in detail the “environmental gain” of the Paranal site vs. the

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[1] We have assumed here that 20% of the CFHT time will be devoted to WFI.

TABLE 3. Summary of Planned Wide-field Imaging Surveys (visible/NIR).

Experiment (1)	WFI (2)	Medium (3)	Bands (4)	Scale (5)	Lim. mag. (6)	Sky cov. (7)	DQE/seeing^2 (8)
Palomar Sch.[1]	43	310[3] plates	J F N	67″/mm	J = 21.5	2.5×10^4	0.04/1″
MEGACAM	1	CCD	B V R I Hα	0.21″	B = 24	10^2	0.80/0.6″
CFHT12K	0.33	CCD	B V R I	0.21″	I_{AB} = 24	25	0.80/0.6″
SLOAN	9	CCD	u′ g′ r′ i′ z′	0.4″	R[2] = 23	10^4	0.4/1″
DENIS	0.02	CCD	I J Ks	1″, 3″, 3″	Ks = 13.5	2.5×10^4	0.61/0.9″
EIS ESO	0.01	CCD	U B_w V_w I_w	0.17″	I = 23.2	24	0.75/0.9″
EIS ESO	0.01	CCD	U B_w	0.17″	BW = 24.3	1.9	0.85/0.9″
EIS ESO	0.01	CCD	U, Gr, Gg, I, K	0.17″	K = 21.5	0.01	0.85/0.9″
BATC	0.95	CCD	15 I, B[3]	0.85″	V = 21	475	
CADIS	0.01	CCD	K′	0.4″	K′ = 21.2	0.28	0.75/1"
LIMITS	0.1	CCD	40 N.B.[4]	0.6″	R = 23.5	20	0.3/1″
Hα Survey	43	160 plates	Hα	67″/mm		7×10^3	0.04/1.6"
APM	25	210[3] plates	IIIaJ	67″/mm	20.5	2.2×10^4	0.04/1″
2MASS	0.02	CCD	J H Ks	2″	Ks = 13.5	2.5×10^4	0.8/0.9″
NOAO	0.07	CCD	I	0.47″	I = 23.5	16	0.8/1″
NOAO	0.36	CCD	B R I J H K	0.27″	I = 26	18	0.8/1″
VST[5]	1	CCD	U ′ B_W V_W R_W I_W	0.21″	R_W = 25.5	300	0.85/0.7″

Column (1) conventional name of the survey; Column (2) detector area in square deg used for the survey; Column (3) plates or digitised images; Column (4) broad or narrow bands covered by the survey; Column (5) scale in arcsec pixel-1; Column (6) limiting surface brightness; Column (7) sky coverage of the survey in square degrees; Column (8) detector quantum efficiency in the R band for optical surveys and K band for NIR surveys, and average seeing;

[1] Data from the CRONA project.

[2] The survey will reach fainter limiting magnitudes in those 5 bands (25 in R) on a strip 2 × 50 square degree, centred on the South Galactic Pole.

[3] 15 intermediate-band filters ($\Delta\lambda$ = 200, 300 Å) from 330 nm to 1 μm will be used for this survey.

[4] 40 narrow-band filters from 400 nm to 1 μm will be used for this survey, plus B, V, R. I.

[5] This is an example of a possible survey with VST.

TABLE 4. Summary of Planned Wide-field Imaging Surveys (visible/NIR) Cont.

Experiment (1)	η (2)	Countr. (3)
Palomar Sch.[1]	1.36	USA-Eur.
MEGACAM	5.76	Fr-CAN
CFHT12K	1.9	France-CAN
SLOAN	22.5	USA
DENIS	0.015	ESO
EIS ESO	0.01	ESO
EIS ESO	0.011	ESO
EIS ESO	0.011	ESO
BATC		USA-China
CADIS	0.03 (3.5 m)	D-E
LIMITS	0.7	CAN
Hα Survey	0.95	UK-AUS
APM	0.81	UK-AUS
2MASS	0.03	USA
NOAO	0.3	USA
NOAO	1.0	USA
VST[2]	13.6	I-ESO

Column (1) conventional name of the survey; Column (2) survey figure of merit as in eq.1; Column (3) countries.

[1] Data from the CRONA project.
[2] This is an example of a possible survey with VST.

La Silla site in Section 4.1 to give a factor 2.35 (3 for the winter season). The telescope area (2.6-m vs. 2.2-m) gives another factor 1.4. Furthermore, the VST telescope is designed to give a square FOV of 1 deg^2 for WFI (to be matched by a 16k $\times$ 16k CCD mosaic), while the corresponding FOV for the 2.2-m[2] is 0.29 square deg.: the gain in efficiency is then by a factor 3.4 from the larger imaging area. Another point concerns the comparisons of efficiency vs. wavelength of the wide-field corrector for the 2.6 m VST telescope and the ESO 2.2-m, see Table 5.

If we consider the average gain in efficiencies as a function of wavelength, then we obtain for the VST an additional factor 1.16 with respect to the ESO 2.2-m telescope[3]. The overall gain in efficiency of the VST vs. the ESO 2.2-m telescope with the 8k $\times$ 8k CCD mosaic camera is a factor 13 (16.5 in the winter season).

Some words are in order for the comparison of the VST with the VLT planned instrumentation. VIMOS will have $\sim$ 0.054 deg^2 FOV, and an estimated ΔT = 0.2: considering the VLT mirror area, VST will be 8.5 times more efficient for WFI than VLT + VIMOS. Although it can reach fainter magnitudes, VIMOS is not a dedicated imaging facility and will have its main use for wide-field spectroscopy, for which it represents a unique facility.

TABLE 5. Corrector efficiencies.

Name	1100[nm]	1000[nm]	800[nm]	600[nm]	400[nm]	365[nm]	350[nm]
ESO 2.2-m	0.77	0.78	0.80	0.82	0.81	0.71	0.47
VST 2.6 m	0.87	0.91	0.925	0.90	0.91	0.90	0.86

Efficiency values for the wide-field corrector for the ESO 2.2-m and for the VST 2.6-m telescope according to the VST proposal. The efficiencies for the ESO 2.2-m are extracted from the ESO document INS 97/001.

4.4. Telescope performances

We explicitly show efficiency curves, values and assumptions used in the estimates of S/N ratios, by considering a CCD mosaic camera with pixel size of 15 μm, 0.24″ pix^{-1} scale, a CCD quantum efficiency as in Figure 3, based on ESO CCD EEV curves, and the measured efficiency of the UVES multi-coating layers (received from ESO on May 28, 1997).

We have assumed an aluminium coating for the primary and the secondary mirrors, and anti-reflection coated surfaces for the corrector and the dewar window. The total transmission factor of these components is shown in Figure 4 for the wide field corrector according to the optical design in the VST proposal. In the same figure we show the CCD response expected ("goal" or minimum specifications).

The telescope performances expected for the VST are based on the efficiency curve in Figure 3 and a detector area of 1 deg^2. We give here three examples of possible science cases which can fully exploit the VST imaging capability and excellent image quality.

The study of large-scale structures in the universe and galaxy evolution requires galaxy catalogues extended over fairly large areas, which can be obtained through multicolour imaging. A very wide survey (several hundred square degrees) with a limiting magnitude in V of 25.5 AB mag arcsec^{-2}, in at least two bands, can fully exploit the capabilities of the VST. In 30 min-exposures, one reaches $Vw_{\rm lim} \sim 25.5$ AB mag arcsec^{-2}, which could translate to $Vw_{lim} \approx 24$ for galaxies (one also has $Iw_{lim} \sim 24$ AB mag arcsec^{-2}, so $Iw_{lim} \approx 22.5$ for galaxies). So, a reasonable estimate can be $\approx$ 50 hrs of exposures per band per 100 deg^2. If one has about 6 effective hours per night, then we need 17 nights to do accurate photometry in two bands over 100 deg^2. With 17 nights of VST time, we will produce an amount of data which is nearly 4 times that produced by EIS "wide".

Furthermore, for the typical magnitude limit of wide area imaging ($R \simeq 24$), one would measure the photometric parameters and colours for several million galaxies, including a large number of low-surface-brightness galaxies whose properties are still largely unknown. Furthermore, thanks to the very high throughput of VST in the UV, large samples of high-z candidate galaxies can be selected through the Lyman break technique. If 1/3 of a year observing dark time can be devoted to deep multicolour imaging (5 bands, $Iw_{lim} \approx 26$ AB mag arcsec^{-2}), one could cover at least 5 deg^2 and obtain a sample of $\sim$ 8000 candidates with z larger than 3.

High performances are expected also for narrow-band imaging with the VST. As an example, for a 6 $\times$ 2000s exposure, the limiting [OIII] 5007 flux at the VST is of 4×10^{-18} erg cm^{-2} s^{-1} (at the 3σ level). In the case of emission line stellar objects like planetary nebulae (PNs), which have a strong emission in the [OIII] λ 5007 line, the limiting [OIII] flux from

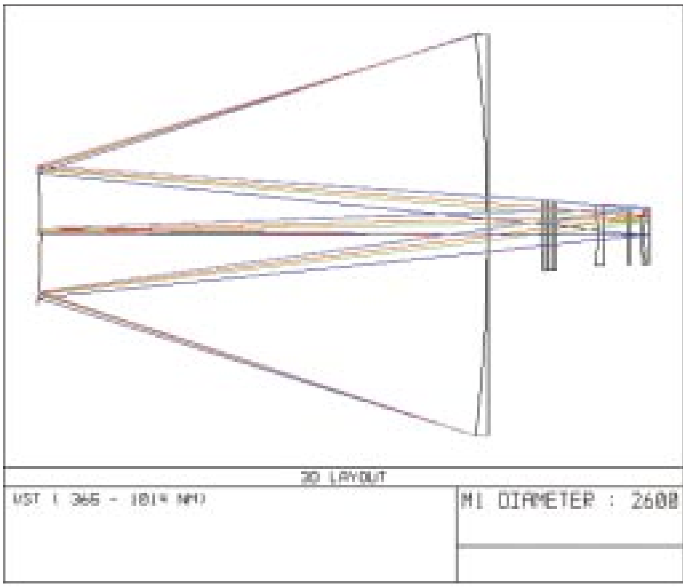

Figure 2: Optical layout in the visual range from 365 to 1014 nm; the wide-field corrector configuration here is with one lens plus the ADC.

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[2] The maximum FOV for a square detector at the ESO 2.2-m focal reducer is 0.29 deg^2.

[3] This value is a lower limit: after the ESO kick-off meeting, the optical design for the wide-field corrector has only two lenses (or one lens plus ADC), so the VST corrector efficiency is higher than the estimated one quoted in the VST proposal.

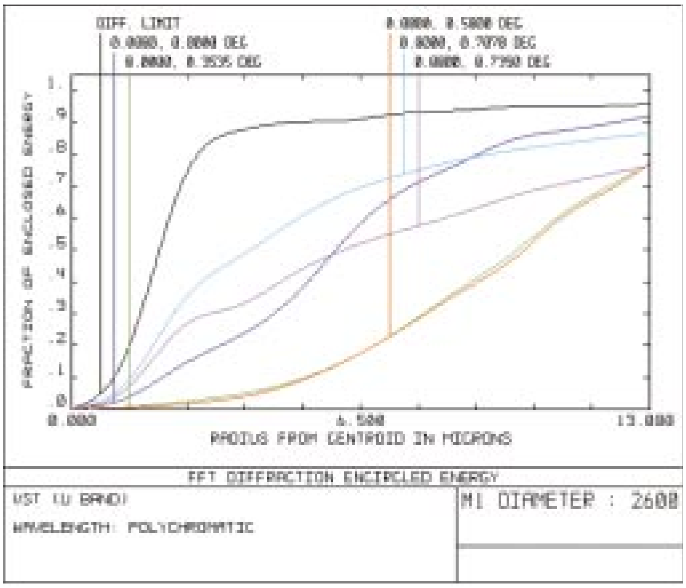

Figure 3. Encircled energy in the U band at different positions in the focal plane.

PNs at the distance of the Fornax/Virgo cluster (17 Mpc) that we can detect at the ESO NTT with EMMI in the multi-object mode is 4 × 10^{-17} erg cm^{-2} s^{-1}. This limiting flux can be detected today with the 4-m CFHT and the 0.25 deg^2 UH8K camera in about 10 × 2000s exposures with *S/N* = 10.

The limiting [OIII] 5007 flux of 6 × 2000s exposures at the VLT plus the multi-object spectrograph VIMOS (R = 2500) is 5 × 10^{-18} erg cm^{-2} s^{-1}: by comparison with the limiting flux in this wavelength range at the VST, we can conclude that such a facility is the ideal instrument to produce catalogues for PN candidates for spectroscopic follow-up at the VLT.

4.5. VST data throughput

In order to estimate the VST data flow, we analyse two different possible cases: survey and deep observations mode. In the first case we assume a total exposure time of 30 min to be split in three exposures, while in the second case we consider 2 × 30 min exposures. In both cases we assume an average length of the night at Paranal of 7 hours and two possible options for the CCD:

- Minimal: 8k × 8k with a 16-bit word. Readout is assumed to be fast (10 s) for survey mode, and slow (85 s) for deep observations. Each frame consists of 0.13 Gbyte of data.
- Maximal: 16k × 16k with 18-bit word. Fast readout time is estimated at 1 min and slow readout at 5.5 min. Each frame consists of 0.58 Gbyte of data.

In both cases we take into account a 10% overhead time for each frame. The data flows (in Gb) produced during the average night are listed in Table 6.

5. Summary

From the comparison of the different characteristics and quality parameters displayed in Tables 1, 2, 3, and 4, plus the consideration based on the high throughput at different wavelengths, it appears that the VST is the most competitive project in the Southern hemisphere for WFI. In conclusion, the need for an ESO WFI facility such as the VST is very strong primarily as a complementary tool for the VLT, and also as an independent survey tool. The ESO community needs a survey facility such as the VST in order to produce the databases which are essential to achieve excellence in the science of the VLT era.

TABLE 6. Data flow in Gbytes per night.

Mode	8k × 8k	16k × 16k
Survey	4.9	20.5
Deep	1.7	6.4

6. Acknowledgements

We would like to acknowledge the members of the Scientific Steering Committee – Jacques Boulesteix, Kenneth C. Freeman, Loretta Gregorini, Angela Iovino, Giuseppe Longo, Tommaso Maccacaro, Yannick Mellier, Georges Meylan, Giampaolo Piotto – for their contributions and support to the VST project. The VST proposal would not have appeared in its form without the work and commitment by Enrico Cascone, Debora Ferruzzi, Valentina Fiume, Guido Mancini, Gabriella Marra, Francesco Perrotta, Pietro Schipani, Gianfranco Spirito, members of OAC TWG. We would like to thank Sandro D'Odorico, the ESO contact point during the initial submission of the VST proposal, for his supervision and support to the project, Richard J. Kurz, Philippe Dierickx, Bernard Delabre, Donald Hamilton for their contribution to the VST project, and Alvio Renzini for his enthusiastic encouragement.

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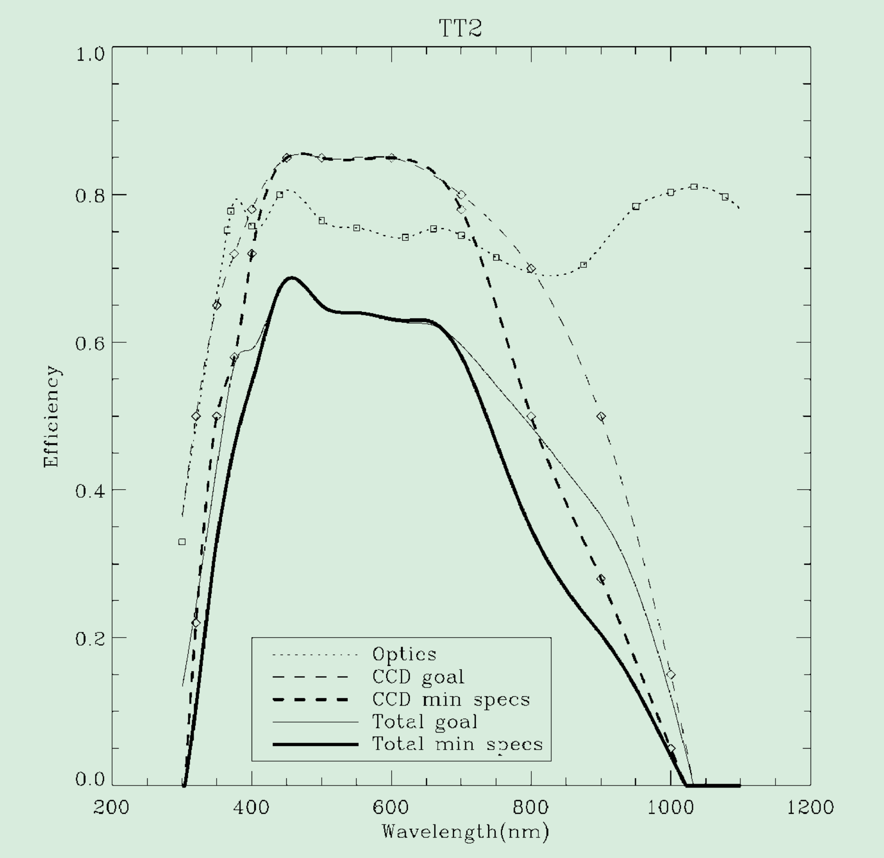

Figure 4. The efficiency curves for the telescope+corrector according to the VST proposal; the CCD response and their product are shown as a function of wavelength.

REPORTS FROM OBSERVERS

Star Formation Toward the "Quiescent" Core NGC 6334 I(N)

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At the time of their birth, young massive stars are deeply embedded in the dense molecular cores from which they form, thus making it impossible for us to observe them directly. The very early stages of massive star formation can therefore only be detected *indirectly* through the effects they have on the surrounding cloud via massive bipolar outflows, enhancements of certain molecular species, or infrared emission from heated dust grains.

At a distance of 1.7 kpc, NGC 6334 is one of the nearest and most prominent regions of ongoing high-mass star formation (Neckel, 1978), but because of its southernly location, it is not well studied. The nebula is associated with a remarkable, filament-like giant molecular cloud (GMC) which contains a chain of 6 distinct sites of recent high-mass star formation (McBreen et al., 1979). Additional evidence for star formation is the emission of vibrationally excited H_2, detected in a large, 20″ resolution map by Straw & Hyland (1989). This map shows bright emission in the H_2 1-0 S(1) line extended over several square parsecs toward the GMC.

In July 1998, we mapped the H_2 1-0 S(1) and Brγ lines toward a significant fraction of the molecular cloud using the Fabry-Perot on IRAC2 at the 2.2-m. This provided *a factor 400 improvement* in spatial resolution over the previous H_2 1-0 S(1) maps of Straw & Hyland (1989). Furthermore, using the SEST in June 1998, we conducted a multi-frequency study of the molecular gas in the NGC 6334 cloud. From these data we find that the NGC 6334 I & I(N) molecular cores, shown in Figure 1, probably contain the youngest sites of high-mass star formation within the NGC 6334 GMC. NGC 6334 I incorporates an ultracompact H II region, two mid-IR sources, a young stellar cluster, a plethora of masers, and at least one (probably two) bipolar outflow(s). The shock-

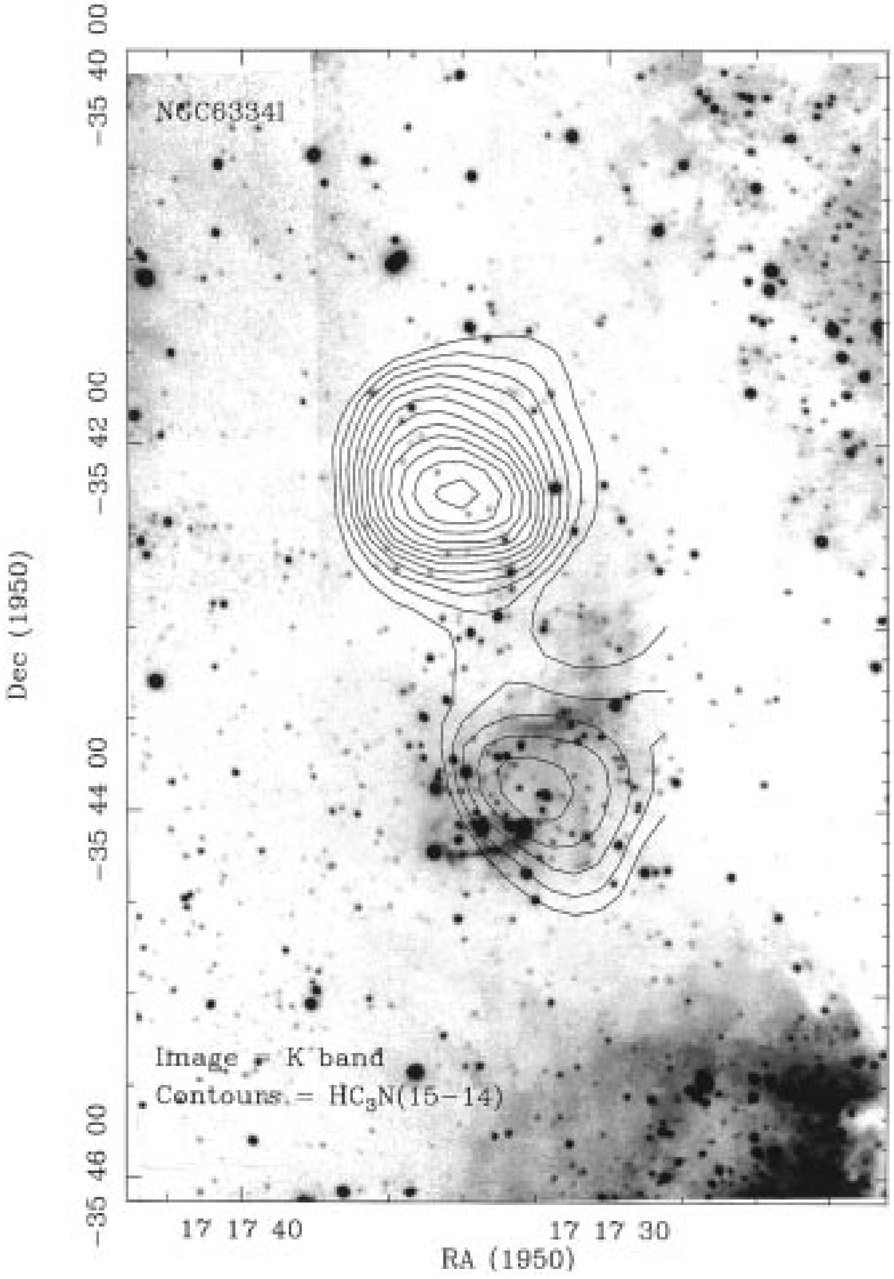

Figure 1: A K-band mosaic (ESO 2.2-metre) of the entire NGC 6334 I region (including I(N)) overlaid with a HC_3N (15–14) emission map (SEST 15-metre). The contour levels are 3 to 9 by 0.5 K km s^{-1}. The dense gas (10^5 cm^{-3}) traced by HC_3N is concentrated into two clumps, the southern clump is coincident with the FIR source NGC 6334 I and the northern core is coincident with I(N). I and I(N) have virial masses of ≈ 790 $M_\odot$ and ≈ 470 $M_\odot$, respectively. We note that $C^{18}O$, which traces moderate density gas (~ 1000 cm^{-3}), is found throughout the mapped regions. The southern core, NGC 6334 I, is clearly a site of active star formation: a young stellar cluster and ultracompact H II region are apparent. Interestingly, the K mosaic shows no clear evidence for star formation in the northern core, I(N).

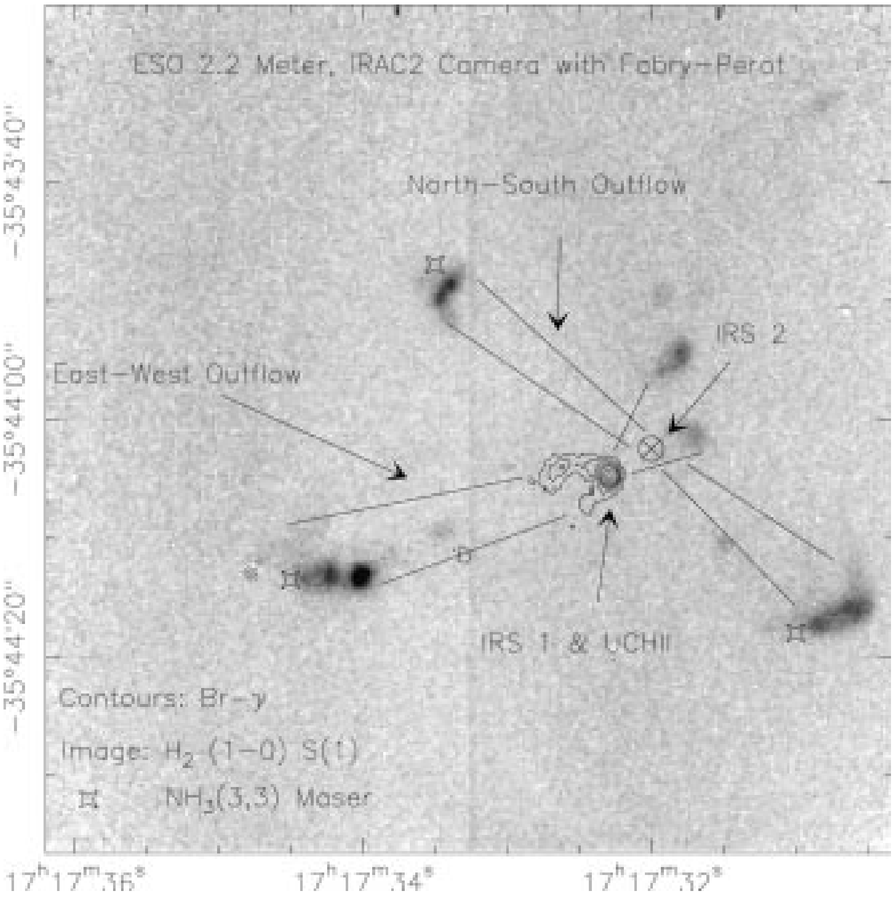

Figure 2: H_2 image of the NGC 6334 I core with contours of Brackett-γ emission. These data had been obtained in an earlier run with the ESO 2.2-metre with a 1″ resolution in the 0.33″ pixel mode. We have outlined the North-South outflow and its candidate source and a proposed East-West outflow. We also show the location of the Brγ line and the close relationship of the NH_3 masers (Kraemer & Jackson, 1995) and the H_2 emission.

excited H_2 1-0 S(1) emission we detected in bow-shock shaped emission knots toward the NH_3 masers detected by Kraemer & Jackson (1995) (cf. Fig. 2), and the broad non-Gaussian line wings detected in the molecular line emission, impressively display these outflows toward NGC 6334 I. In contrast, I(N), a cooler source has only been detected at submillimetre or millimetre wavelengths. Interestingly, I(N) contains several masers whose presence, far from any known site of active star formation, has been an enigma.

From our SEST data, we confirm that the NGC 6334 I(N) core is chemically quiescent and much cooler when compared to its southernly neighbour NGC 6334 I. Considering the apparent cluster embedded within the NGC 6334 I core, this is not surprising as much of the molecular material within this core must have been heated and processed by the embedded young stars. However, NGC 6334 I(N) shows some very surprising peculiarities: bright emission lines of sulfur-bearing molecules and SiO line emission with broad line wings. These strong lines and their attendant line wings are clear evidence for a molecular outflow and shock chemistry in this seemingly quiescent molecular core. Maps of the blue and red line wings in the observed transitions of SiO indicate a bipolar flow (cf. Fig. 3). The near-infrared maps obtained with the 2.2-m provide further evidence for outflows in I(N) through the detection of vibrationally ex-

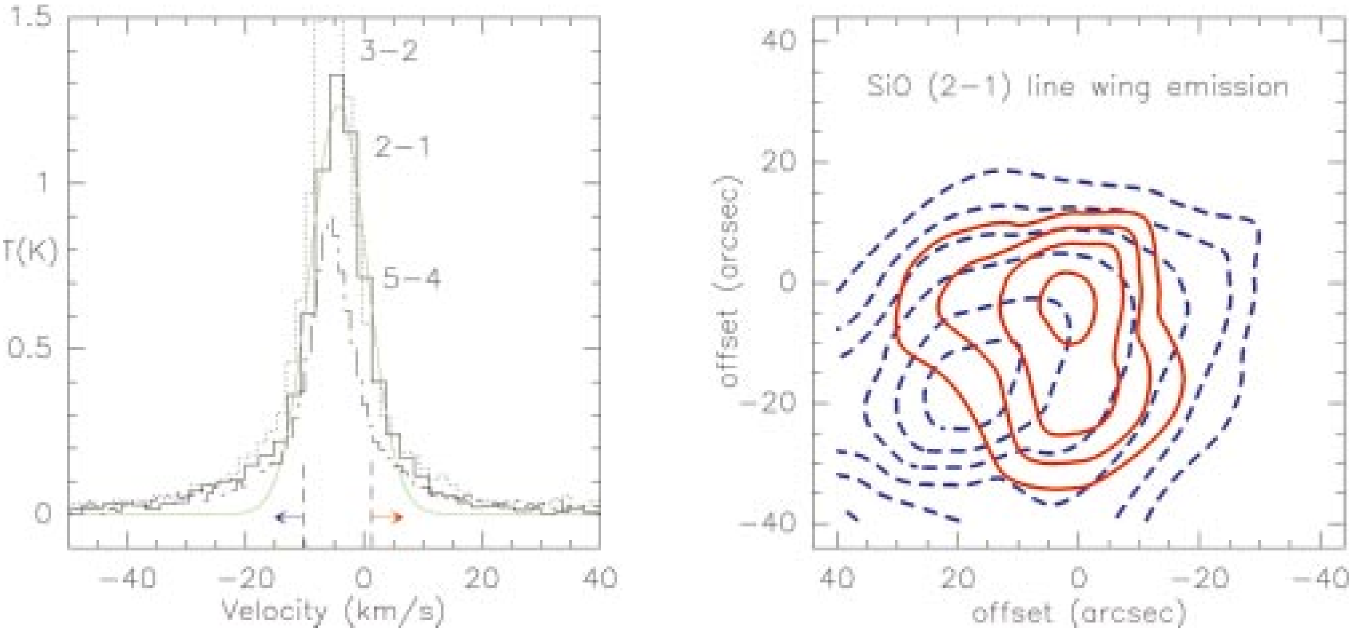

Figure 3: The panel on the left shows the SiO spectra obtained toward NGC 6334 I(N). The line intensities are about twice as strong as for the SiO detected toward NGC 6334 I. A Gaussian has been fitted to the SiO(2-1) line. For all transitions non-Gaussian line wings out to ≈ –40 km s^{-1} and ≈ 25 km s^{-1} can be detected. The panel on the right shows the integrated emission from the blue and red line wings of the SiO(2-1) line as indicated in the left panel by the two arrows. The bipolar outflow is clearly detectable and has also been mapped with about half the FWHM beamsize at the frequency of SiO(5-4).

cited H_2 emission toward NGC 6334 I(N) (cf. Fig. 4). Thus, NGC 6334 I(N) now appears to harbour ongoing star formation, which explains the previously enigmatic presence of masers toward I(N). We suggest that I(N) is in an interesting transition phase, transforming from a chemically quiescent to a shock/outflow-dominated molecular core. Assuming that its southernly companion, NGC 6334 I, passed through a similar transition phase before entering the observed hot core chemistry, these two molecular cores, embedded within the same parental molecular cloud and separated by less than 0.5 pc, will allow for a unique case study of the chemical and physical evolution of molecular cores in their earliest phases after the onset of star formation (Megeath & Tieftrunk, Tieftrunk & Megeath, in preparation).

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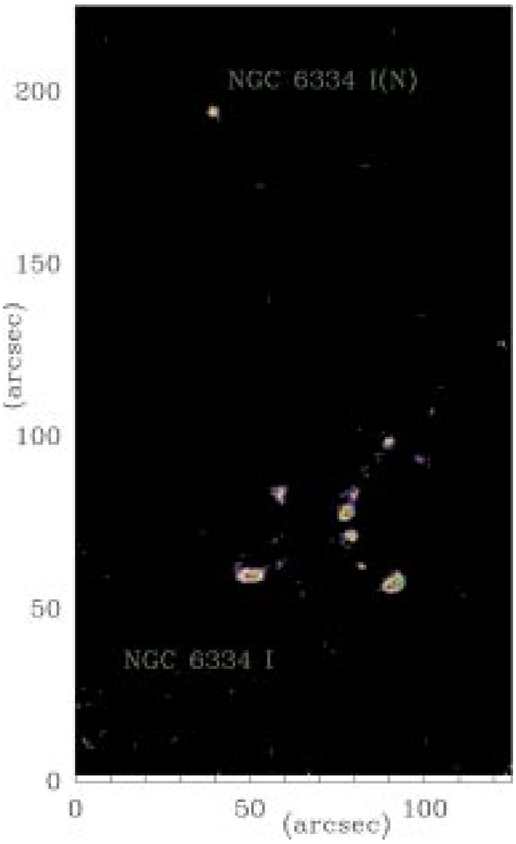

Figure 4: $H_2$1-0 S(1) emission toward NGC 6334 I and I(N) from our Fabry-Perot imaging with the 2.2-m in July 1998. The lower part of this figure shows the same H_2 emission knots as Figure 2, but with higher dynamic range. Relative offsets are given in arcseconds from an arbitrary off-position, chosen to align the two FP-fields. We caution the reader that the registration of the data in this figure is preliminary and may have absolute errors of several arcseconds. Note that no *continuum and* no *Brγ emission could be detected toward the shock-excited H_2 emission knots.*

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Molecular Gas in 30 Doradus

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Introduction

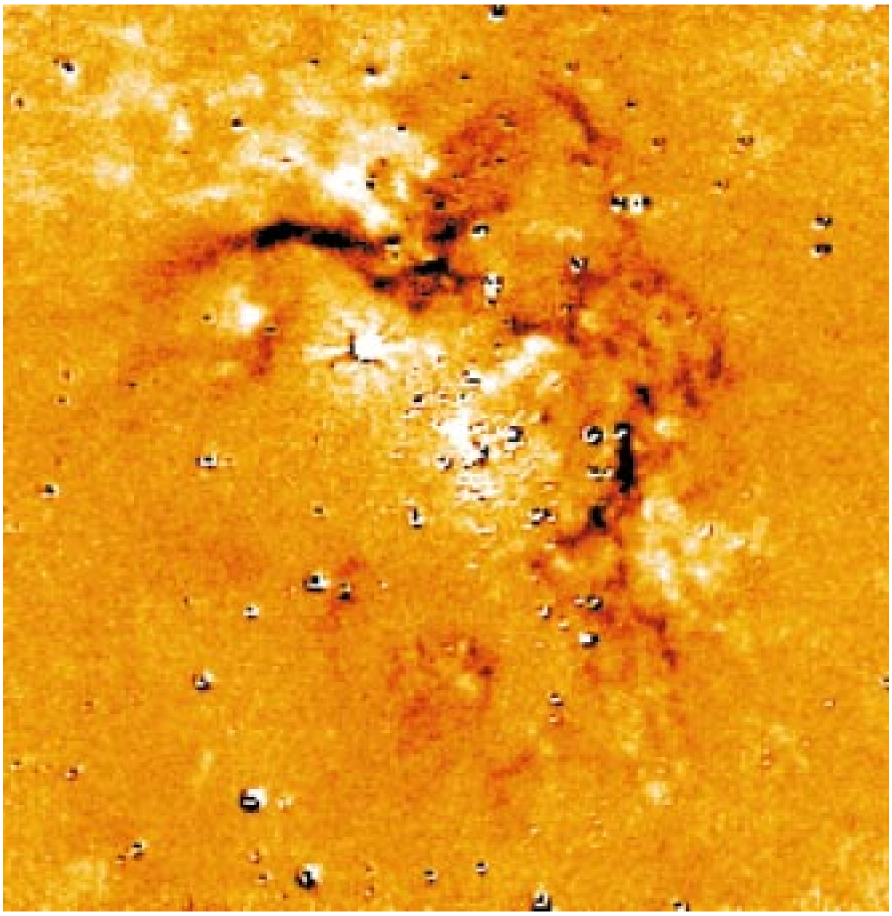
The Large Magellanic Cloud (LMC) contains numerous star-forming regions (SFRs) in an environment considerably different from the Galaxy. As in our Milky Way, SFRs in the LMC include complexes of ionised gas, patches of dust, and clusters of young stars and share the same markers of star formation: protostellar objects (Jones et al. 1986; Hyland et al. 1992), compact infrared sources (Schwering & Israel 1990; Rubio et al. 1992), OH and H_2O masers (Whiteoak & Gardner 1986; Caswell 1995), etc. They show, however, significant differences: the ionising radiation is stronger, the luminous stars are less deeply embedded, there is a lack of far-IR brightness peaks, and substantially less cold molecular gas (Cohen et al. 1988; Israel et al. 1993; Kutner et al. 1997; Johansson et al. 1998). The SFRs in the LMC should be important stepping stones between Galactic SFRs and those in more distant galaxies. In particular, the giant H II region 30 Doradus is thought to be a keystone object for understanding the “starburst” phenomenon in active galaxies (cf. Walborn 1991). Much larger than any Galactic SFR, the 30 Doradus region contains luminous clusters of massive young stars emitting intense UV radiation and powerful stellar winds which have created loops and shells of ionised gas, and shows evidence for a highly efficient formation mechanism unmatched in Galactic molecular clouds (Massey and Hunter 1998). We summarise here the results of an ongoing investigation of the characteristics of the highly excited molecular gas and cold molecular gas toward the centre of the 30 Doradus region, made through observations of H_2 and CO(2→1) line emission, respectively.

Cold Molecular Gas

CO emission from the 30 Doradus region was first detected, using the Columbia millimetre radio telescope, by Melnick & Rubio (1985). Their pointed, low angular resolution (8.8′) observations showed a weak CO line emission with several velocity components. Higher sensitivity CO mapping of a region of $\sim 1°$ centred near the exciting cluster of the H II region (hereafter the R136 cluster), made with the same instrument, were reported by Garay et al. (1993). They suggested that the CO emission from the 30 Doradus region arises from small, dense molecular clumps that are embedded in a mainly atomic but partly molecular interclump medium where CO has been destroyed by photodissociation due to the strong UV radiation field present in the area.

As part of the ESO-SEST Key Programme: CO in the Magellanic Clouds, Johansson et al. (1998) mapped the CO(1→0) line emission from the 30 Doradus region with a tenfold higher angular resolution (45″) than in previous works. They identified more than 30 molecular clouds within a region of $24' \times 24'$, having typically sizes of 10 pc and masses of $\sim 2 \times 10^4$ $M_\odot$, confirming the suggestion made by Garay et al. (1993). In particular, close to the R136 cluster, Johansson et al. (1998) detected two CO clouds located toward the north-east and west of R136 (clouds # 10 and 13, respectively) and which lie close to the edg-

Figure 1: Composite image of the 30 Doradus Nebula, using the 2.12µ and 2.16µ narrow-filter images taken with CIRIM (Nicmos III, 256 × 256 IR camera) at the 1.5-m telescope at Cerro Tololo Inter-American Observatory. The individual images cover an area of 5′ × 5′ centred in R136 and the exposures times are 1 hour and 30 minutes for the 2.12µ H_2 and 2.16µ Brγ, respectively. The Brγ image has been subtracted from the H_2 image. Red-brown colours indicate Brγ emission while yellow-white colours indicate H_2 emission. The scale is 1.16″/pix and the field shown is 4.4′ × 4.5′. North is at top, east to the left.



es of filaments of ionised gas characteristic of this giant HII region. Cloud 10 is the most luminous and massive cloud of the region surveyed, having a CO luminosity of 9.9×10^3 K km s^{-1} pc^2 and a virial mass of 3.8×10^5 $M_\odot$. Near IR images show the presence of an IR cluster towards Cloud 10 and a chain of knot-like features towards Cloud 13 (Rubio et al. 1992). The knots seem to be associated with early-type (O3) massive stars, suggesting that massive star formation is currently taking place within dense molecular clumps embedded in the ionised gas. Further evidence for a new stellar generation of young massive stars in the 30 Doradus Nebula is presented by Rubio et al. (1998).

Excited Molecular Gas

Recently we undertook deep imaging, in the 2.12µ 1-0 S(1) line of H_2 and 2.16µ Brγ recombination line of hydrogen using the CTIO 1.5-m telescope, of several LMC SFRs in order to investigate the spatial distribution of H_2 and ionised gas with respect to the CO molecular clouds (Probst & Rubio 1998). Toward the 30 Doradus region a 5′ × 5′ area was imaged, with 1.16″/pix resolution, showing that the H_2 emission is clumpy, with numerous knots and with a reticulated pattern in contrast to the ionised gas which shows a filamentary structure in Brγ. These near-IR images are considerably more sensitive than those reported by Poglistch et al. (1995) and have considerably higher angular resolution than the low-surface-brightness line emission observations of Pak et al. (1998). Figure 1 shows a composite image, made using the 2.12µ and 2.16µ narrow-filter images (1-hour and 30-min exposures, respectively) in which the Brγ image has been subtracted from the H_2 image. The Brγ emission (shown in red-brown colours) clearly shows filaments and arc structures of ionised gas towards the west and north-east of the central cluster, as well as the filamentary structure of the nebula. On the other hand, the distribution of H_2 (shown in yellow-white colours) is characterised by compact knots of strong emission, near the centre of the image, and two extended areas of weaker emission, one toward the NE and the other toward the

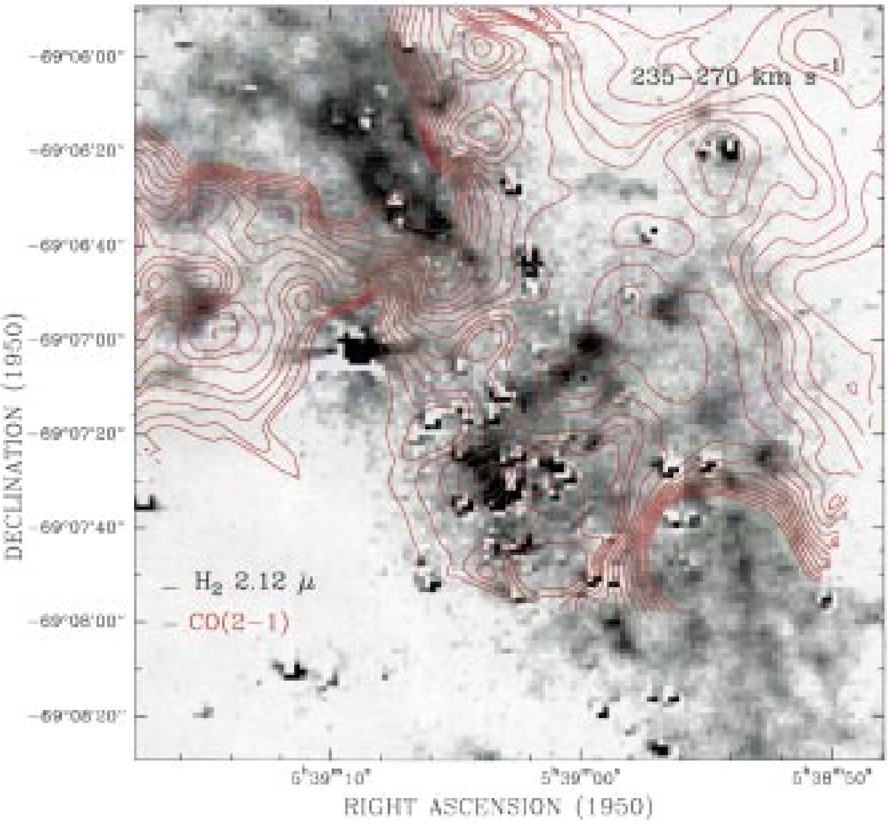


Figure 2: Contour map of velocity integrated CO(2→1) line emission from the 30 Doradus region, superimposed on the 2.12µ H_2 image taken with CIRIM at the 1.5-m telescope at CTIO. The velocity interval of integration ranges from 235 to 270 km s^{-1}. The contour levels are from 0.8 K km s^{-1} (~ 4σ) to 2.4 K km s^{-1} in steps of 0.4 K km s^{-1} and from 3.2 to 10 K km s^{-1} in steps of 0.8 K km s^{-1}.

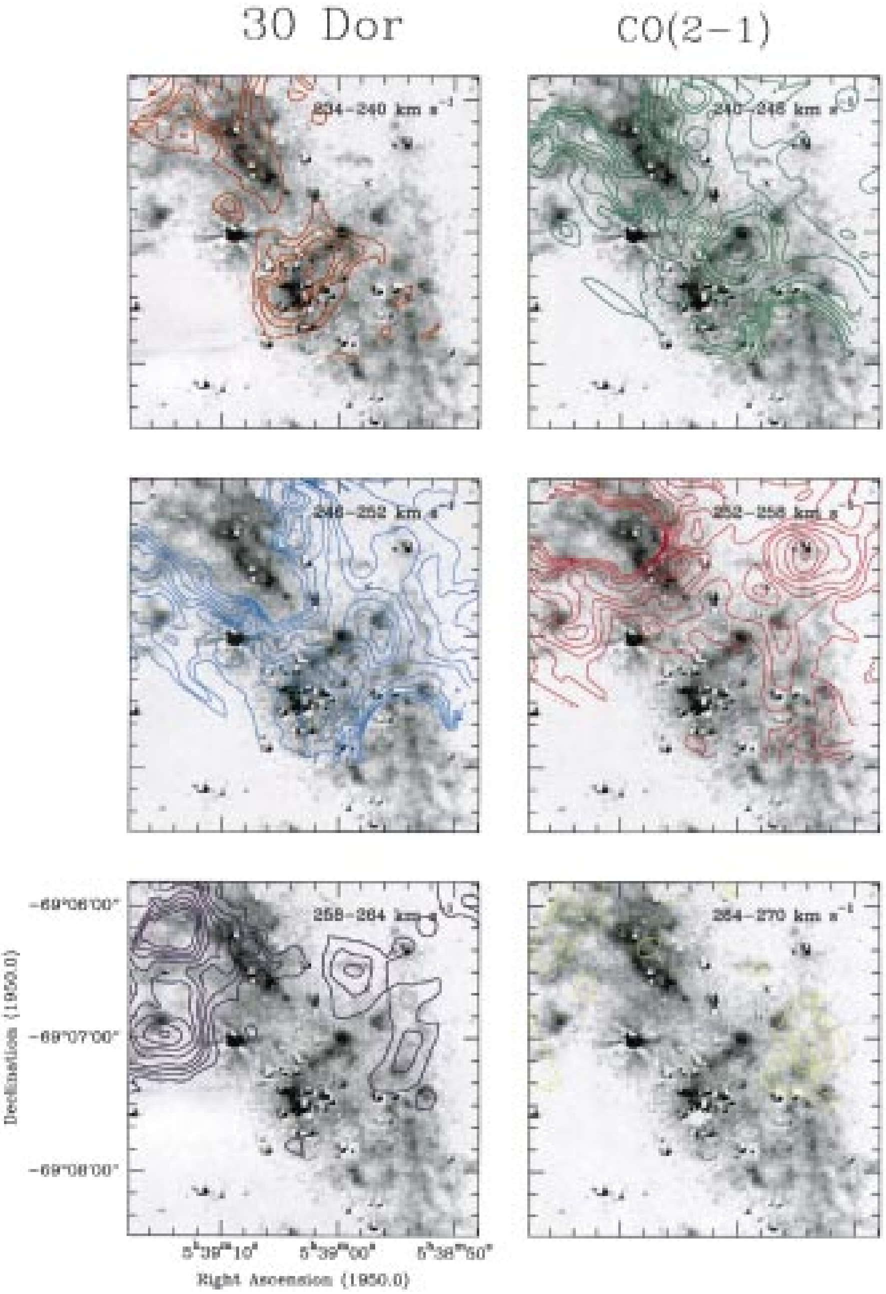


Figure 3: Channel maps of the integrated CO(2→1) line emission over velocity intervals of 6 km s^{-1}, in the velocity range from 234 to 270 km s^{-1}, superimposed on the same H_2 image shown in Figure 2. The contour levels are from 0.25 K km s^{-1} ($\sim 4\sigma$) to 1.0 K km s^{-1} in steps of 0.25 K km s^{-1} and from 1.5 to 3.0 K km s^{-1} in steps of 0.5 K km s^{-1}. The position of R136 is indicated by a white star symbol in the lower-right panel.

SW of R136. The extended emission is found projected toward the CO clouds detected in the near vicinity of R136 by Johansson et al. (1998). Projected toward the NE H_2 region are known protostars and an H_20 maser feature. The extended SW H_2 region exhibits a peculiar bubble structure apparently unrelated to the Brγ emission. These bubbles have roughly the same linear dimensions as those seen in the Orion SFR (Tanaka et al. 1989), but unlike the latter do not contain hot young stars or ionised gas, and show a more clumpy structure. The nature of the bright H_2 knots seen in the vicinity of R136 is particularly intriguing; they are not associated with stars, ionised gas, nor with CO emission as reported by the Key Programme survey (Johansson et al. 1998).

Observations and Results

The presence of concentrations of excited molecular gas, as revealed by the 2.12μ emission, in regions near the central cluster R136 where no CO(1→0) had been detected by Johansson et al. (1998) clearly calls for more sensitivity CO observations of the region. Hence, we undertook a deep survey of the CO(2→1) line emission towards the H_2 knots and bright structures. This line was chosen in order to benefit from the higher angular resolution provided by SEST at the frequency of 230 GHz (23″ or 6 pc at the distance of the LMC). The aim of the observations was to search for weak CO emission, tracing cold molecular gas, that might be associated with the hot molecular gas of the H_2 knots, and to study the physical conditions of molecular clouds in the presence of an intense ultraviolet radiation field.

The observations were made during two observing runs (March 1997 and January 1998) using the SEST telescope on La Silla, and performed in the position-switching mode using a nearby reference position free of CO(2→1) emission. Only linear baseline fits were needed to reduce the data. The rms noise achieved in a single channel 0.054 km s^{-1} wide, is 0.07 K. We fully mapped, with 10″ spacings, a region between Clouds 10 and 13 which encompasses the H_2 knots found in the near IR. Emission is detected in most of the mapped region, but with an intensity of typically 3–4 times lower than that of the emission mapped by Johansson et al. (1998).

Figure 2 shows a contour map of the CO(2→1) emission integrated over the velocity interval from 235 km s^{-1} to 270 km s^{-1}, superimposed on the 2.12μ H_2 image. Besides the strong emission from Cloud 10 (NE region of the map) and Cloud 13 (SW region of the map), particularly notable is the detection of emission from a clumpy structure, located between Clouds 10 and 13, having an elongated morphology along a SE-NW direction. In addition, at least two other CO(2→1) clumps are clearly detected, one located in the east and the other in the north-west region of the map. The central, clumpy CO(2→1) structure is closely associated with the H_2 knots and roughly follows their morphology. However, the peak of the CO clumps are in general not exactly coincident with the peaks of the H_2 knots.

The velocity structure of the CO(2→1) emission from the 30 Doradus region is presented in Figure 3, which shows channel maps of the emission integrated over velocity intervals of 6 km s^{-1}, superimposed on the 2.12μ H_2 image. The strong emission from Cloud 10 is clearly seen in all, but the last, channel maps, while emission from Cloud 13 is seen in the range from 240 to 258 km s^{-1}. Note that the CO emission above 10 K km s^{-1} is not contoured in Figure 3 to allow a clear display of the weaker emission pertained to this work. From an analysis of the channel maps we have identified seven molecular clumps in the mapped region (other than Clouds 10 and 13), with velocities ranging from 236.7 km s^{-1} to 268.8 km s^{-1}. The radii of the clumps range from 4 to 7 pc, the line widths range from 2.4 to 7.9 km s^{-1}, and the CO luminosities range from 0.5×10^2 to 4.3×10^2 K km s^{-1} pc^2. Compared to the average parameters of LMC molecular clouds, derived from a total of about 100 CO clouds mapped with the SEST under the CO Key programme (Rubio 1997), these clumps are smaller in size by a factor of ~ 4 and

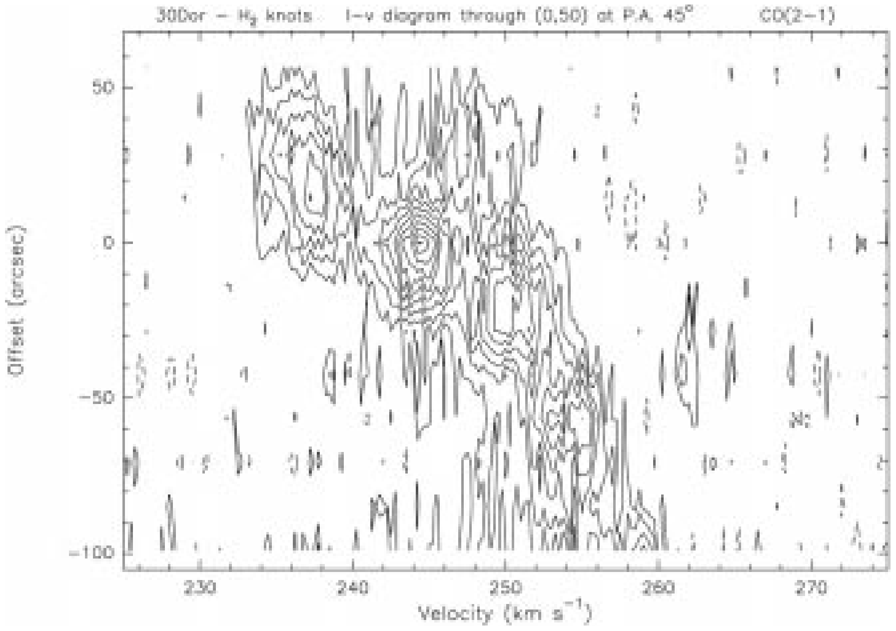


Figure 4: Position-velocity diagram of the CO(2→1) line emission from the central region of 30 Doradus along a direction with a position angle of 45° passing through α (1950) = $5^h39^m00.2^s$, δ (1950) = –69°07′10″. Contour levels are –0.07, and 0.07 to 0.7 K in steps of 0.07 K. The spectral data used to make this diagram have been smoothed to a velocity resolution of 0.25 km s^{-1}.

have CO luminosities lower by a factor of ~ 10^2. Assuming that the CO clumps are in virial equilibrium, we estimate clumps masses in the range from 5×10^3 to 5×10^4 $M_\odot$. This hypothesis is, however, arguable for clouds in the 30 Doradus region due to the large amount of mechanical energy that has been deposited in the region by the recently formed massive stars.

Discussion

The CO(2→1) emission associated with the chain of H_2 emission shows a clear gradient in velocity along a SE-NW direction. In the lowest velocity interval (234–240 km s^{-1}) the CO emission arises from a region associated with the south-eastern most H_2 knots, in the next velocity interval (240–246 km s^{-1}) it peaks near the strongest H_2 knot, while in the velocity interval 246–252 km s^{-1} it is mainly associated with the north-western most H_2 knot in the chain. The velocity gradient is best appreciated in Figure 4 which shows a position velocity plot of the emission along a direction with a position angle of 45° passing through α (1950) = $5^h39^m00^s.2$, δ (1950) = –69°07′10″. From this figure we measured, for the CO emission associated with the H_2 chain, a velocity gradient of ~ 0.37 km s^{-1} $arcsec^{-1}$ (or 1.4 km s^{-1} pc^{-1} at the distance of 55 kpc) over a region of ~ 50″ in length. If these motions are due to gravitationally bound rotation around a core of mass M_c, then the observed velocity gradient implies that $M_c \sim 1.4 \times 10^5$ $M_\odot$ within a 7 pc core radius (cf. Armstrong, Ho, & Barret 1985).

While the presence of such a massive core cannot be ruled out at present, we believe that the observed velocity field in the 30 Doradus region is most likely produced by the expansion of molecular gas driven by the powerful stellar winds from the luminous stars located in the central part of 30 Doradus. The interaction of stellar winds with the ambient interstellar medium has been extensively studied by Castor et al. (1975) and Weaver et al. (1977). Assuming that the characteristic velocity of expansion of the clumps is 16.7 km s^{-1} (equal to the largest observed relative velocity of the clumps with respect to the ambient cloud velocity) and that they are located at a characteristic radius of ~ 16 pc (equal to the radius of the region encompassing the seven clumps), then the stellar wind power required to form the observed structure, assuming a medium with an initial ambient density of 10^4 cm^{-3}, is 4×10^{39} ergs s^{-1}. The power of the stellar wind originating in R136 is estimated to be 4×10^{39} ergs s^{-1} (Cox & Deharveng 1983), hence it alone is sufficient to explain the expansion motions of the CO clumps in 30 Doradus.

The detection of compact H_2 knots projected close to R136 seems to indicate that dense molecular structures can survive the strong winds and intense ionising radiation produced by the luminous young stars of the compact R136 cluster. The peak intensities in the 1-0 S(1) line from the three strong H_2 knots of the chain range from ~ 4×10^{-5} to 6×10^{-5} ergs s^{-1} cm^{-2} str^{-1}. If this H_2 emission is produced in a photodissociation region exposed to a UV radiation field with an intensity ~ 3500 times larger than the average intensity of the Galactic interstellar field (Werner et al. 1978), then the observed intensity in the 1-0 S(1) line implies that the emitting region has a density of ~ 2×10^5 cm^{-3} (Sternberg & Dalgarno 1989). To compute the total intensity in H_2 from the intensity in the 1-0 S(1) line we used a scale factor of 50 (cf. Goldshmidt & Sternberg 1995).

Conclusions and Outlook

We suggest that the weak CO clumps found projected toward the R136 region correspond to dense fragments of gas that are remnants of the original molecular cloud in which the young massive cluster R136 was born. Due to the strong winds from the massive stars and the large UV radiation field generated by them, the parental molecular cloud was fragmented and dispersed, and a cavity has been blown. The question arises as to the spatial location of the H_2 knots: Are they embedded within the giant H II region or are they rather located in their outskirts? If the dense fragments of molecular cold gas are within the hot cavity it implies that they have not been photoevaporated by the strong ionising radiation that has destroyed the rest of molecular gas. There are several arguments against this hypothesis, however. The velocities of the clumps are not close to the ambient cloud velocity, as expected in this scenario, but displaced by typically 10 km s^{-1}. Further, the clumps should exhibit an externally ionised envelope which, however, is not detected in the Brγ image. Most likely the CO clumps are remnants or fragments of a supershell of molecular gas that has been driven by the powerful stellar winds from the cluster of luminous young stars. This hypothesis is supported by the observed velocity field of the clumps. We envisage that the cold and dense fragments are exposed to the strong photodissociating UV radiation field from the central cluster and hence are being heated on their periphery. The molecular gas is being excited and emits by fluorescence in the 1-0 S(1) infrared line as seen in the 2.12μ images. Alternatively, the CO clumps could be undergoing shock interaction with the strong winds of the massive stars in the central cluster and thus, emitting in the NIR. The molecular/ionised gas interface will be investigated through a spectroscopic follow up to determine the excitation mechanism, temperature, and column density of the excited H_2.

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OTHER ASTRONOMICAL NEWS

A Fresh Look at the Future: “La Silla 2000++”

B. NORDSTRÖM, Chair, ESO Users’ Committee

Background

Investments in observational facilities on a European scale, whether on a VLT or LSA scale or in telescopes of more modest size, must be based on careful medium- and long-term planning. As scientific priorities and external conditions (e.g. budgets!) change, so the plans must be revised periodically.

In 1995, a joint STC/ESO/UC Working Group presented a plan for the mid-term future of La Silla, Scientific Priorities for La Silla in the VLT Era (ESO/STC-174; see also *The Messenger* 83, p. 48, 1996). This report made a first attempt to chart the complementary roles of the Paranal and La Silla observatories in the commissioning phase of the VLT, based on an ESO-wide questionnaire survey of the plans and priorities of the user community.

From an analysis of the replies, recommendations were derived for additions to and reductions in the facilities offered by ESO on La Silla, with the aim to optimise the scientific returns of the resources that could be realistically expected to be available. It was also recommended to revise such planning roughly every three years.

La Silla 1998: Current Status

Three years later, First Light on UT1 has been achieved with tremendous success (see the last issue of *The Messenger*!). The whole schedule for commissioning the VLT telescopes is thus firmly consolidated. Meanwhile, a new set of powerful VLT instruments has been approved for construction on an accelerated schedule. Many of us are already eagerly preparing applications for VLT observing time.

At the same time, many of the chief recommendations for the future of La Silla have been implemented, as evident from the last several issues of *The Messenger*.

Most importantly, the refurbished NTT is back in operation as a superb 3.5-m telescope with much-improved performance and equipped with new instruments (SOFI and SUSI2) which are second to none in their fields. In the process, invaluable lessons have been learned for the commissioning and operation of the VLT.

The 3.6-m telescope has achieved an image quality never seen during its previous 20 years of operation, and will soon receive a new, powerful mid-infrared instrument, TIMMI2. Its control system is also being upgraded. Moreover, the CES has been upgraded to a new class of high-resolution science with the new Very Long Camera, and is being provided with a permanent fibre link to the 3.6-m.

Among the smaller telescopes, the 2.2-m is receiving a new control system as well as a powerful Wide Field Imager based on an 8 k × 8 k CCD array. The 1.52-m ESO telescope will be equipped with the new FEROS spectrograph later this year, and a dome upgrade programme at the 1.54-m Danish should lead to improved image quality there. Moreover, the DENIS and EROS2 projects are going ahead full blast and producing lots of exciting science.

A top priority need for the future, wide-field imaging with high spatial resolution, is being addressed through the Napoli-ESO project to construct a 2.5-m VLT Survey Telescope on Paranal, covering a 1-degree field on a 16k × 16k CCD array from about 2001. And on the down side, the Schmidt, the CAT 1.4-m and the ESO 50-cm telescopes have been closed as general ESO facilities.

Last, but not least, ESO is rapidly moving into a welcome position of leadership as regards CCD detector and controller technology, with new 2k × 4k chips being fielded at a rapid pace with the new, lightning fast and low-noise FIERA controller.

A Fresh Start

The developments outlined above make this an opportune time to give the 1995 plans a thorough overhaul. Accordingly, the Director General has asked the Users’ Committee to poll the user community in the ESO countries regarding their wishes for the future of La Silla, and the order of priority of these wishes. The replies must be evaluated on the background of an uncertain, but likely level or even decreasing budget for La Silla, cf. also the policy paper “The Role of ESO in European Astronomy” in the March-98 issue of *The Messenger*.

As before, synergy with the VLT is an important consideration: For many projects, the smaller telescopes (below 4 metres) are the platform we need to plan and prepare VLT projects. For some, the VLT will outperform any likely La Silla facility by a large factor. However, pressure on available VLT time will be great and other programmes can or even must be conducted on smaller telescopes than the VLT.

La Silla is the natural home for such projects, using existing, new or upgraded facilities. The task at hand is to prepare plans that will optimise the scientific returns of the future La Silla within realistic budgetary limits.

"La Silla 2000++"

A working group has been set up, consisting of 2 members from each of UC, STC and ESO, provisionally nicknamed "La Silla 2000++". The WG will solicit the wishes, views, and priorities of the ESO user community for the period 2000–2006 over the next few months, through a questionnaire accessible via the ESO WWW home page (http://support.eso.org/ls-questionnaire) and through other suitable channels. We urge all interested colleagues to give us your imaginative ideas and constructive suggestions for the benefit of us all!

Based on the replies received, the WG will prepare a summary report and a set of recommendations which will be presented to the Director General and eventually to the ESO Council. Readers will be kept informed of the progress of this work through future issues of *The Messenger*.

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6th ESO/OHP Summer School in Astrophysical Observations

M.-P. Véron, and G. Meylan

The 6th ESO/OHP Summer School was hosted again at the Observatoire de Haute-Provence (OHP) from 15 to 25 July 1998. The school, held only every second years, selects 18 of Europe's most promising young doctoral students in astronomy. Courses of lectures, observations, and analysis form the intellectual menu which is aimed at teaching the process of extracting astrophysically digestible results from the photons harvested at the telescopes, such as the ESO VLT, whose four telescopes will become available to the community in turn during the next few years.

The OHP is exceptionally well equipped to provide all the required ingredients of success for the school. The four main telescopes, reserved for the students, have state-of-the-art instruments and detectors. The observatory, in its beautiful site, is ideally placed to provide a proper mix of clear skies and other facilities, all contributing to the ambience which insures that the various items on the menu form a coherent whole and inspire the students, their tutors, and all around to pursue the tasks at hand with vigour and enthusiasm.

The basic programme for the school was unchanged from previous years. Students were formed into groups of three, and each group was assisted by a tutor. The tutors helped the students prepare observing programmes for both imaging and spectroscopy. The telescope and instrument set-ups were prepared carefully according to the requirements of the programmes. The observations were performed and data analysed.

The tutors this years were Rodrigo Ibata, Marco Scodeggio, and Patrick Woudt from ESO (Garching), Torsten Böhm from Observatoire Midi-Pyrénées (Toulouse), Catherine Boisson from Observatoire de Paris (Meudon), and Gérard Jasniewicz from Université de Montpellier. There is no doubt that the success of the school is very much a result of their efforts; this was confirmed to us by the students themselves.

R. Ibata led G. Bergond, I. Burud, and J. Vink in a determination of the velocity ellipsoid in the solar neighbourhood. The most direct way to accomplish this is to measure radial velocities to high precision from high-resolution spectra they obtained at the 1.52-m telescope with the Aurelie spectrometer. From broad-band (BVRI) images of the same stars obtained at the 1.20-m telescope, they derived their extinction-corrected absolute magnitudes, addressing the issue of whether the observed dispersion in the Hipparcos main sequence is intrinsic or simply due to the effects of reddening.

M. Scodeggio led J. Dias, R. Kotak, and B. Wolff in a study of scaling relations of early-type galaxies, such as the Faber-Jackson and the Fundamental-Plane relations. Such relations involve determinations of a scale radius and a corresponding surface brightness they obtained from images of the sample galaxies acquired at the 1.20-m telescope; the required velocity dispersion determinations were deduced from their spectroscopic data obtained with the CARELEC spectrometer at the 1.93-m telescope.

P. Woudt led N. Przybilla, M. Van den Berg, and A. Zappelli in a study of an accurate determination of the galactic foreground extinction. The 1.93-m telescope with CARELEC was used to obtain spectra roughly centred on the redshifted Mg *b* lines, i.e., at about 5200–5300 Å, providing a reddening index calibrated with Lick standard stars. Images in *B* and *R* bands were acquired with the 1.20-m telescope. An empirical relation between the Mg_2 spectral index and the $(B - R)_0$ colour of elliptical galaxies was used to determine the reddening of the sample galaxies.

Under the guidance of T. Böhm, J. Kahanpää, P. Kervella, and Y. Momany studied the activity of Herbig Ae/Be stars. According to standard theory of stellar evolution, these stars are not supposed to possess outer convection zones, but rather convective cores surrounded by radiative subphotospheric envelopes. However, observations unveiled spectral variations in such stars, with strong stellar winds. These students used Aurelie spectra from the 1.52-m telescope to monitor possible spectral variability of "active" lines, which are good indicators for the presence of a magnetically structured stellar atmosphere. Images, acquired with the 1.20-m telescope, of Herbig Ae/Be stars in young open stellar clusters provided powerful constraints on early phases of stellar evolution.

C. Boisson led M. Billères, G. Marino, and S. Wolf in a study of the properties of the host galaxies of AGNs, since the relationship of a Seyfert nucleus to its host galaxy remains an important unanswered question. They used spectroscopy, acquired with CARELEC at the 1.93-m telescope, for a sample of AGNs selected to cover the various classes of active galaxies as well as different environments. Broad-band images obtained with the 0.80-m telescope allowed the study of the morphological features of these galaxies.

Under the guidance of G. Jasniewicz, B. Parodi, A. Shaker, and L. Vannier studied a few post-AGB stars, objects which suffer some of the violent and final phases of stellar evolution, such as the He-shell flash. From high-resolution spectra obtained at the 1.52-m telescope with Aurelie, they focused on the C2 molecular bands, the absorption components of the Na I D, and stellar emission lines. Broad-band (UBV) images of the same stars obtained at the 0.80-m telescope allowed estimates of the colour of the central objects and of the surrounding faint nebulae.

The other major ingredient in the school was a series of invited lectures on topics related to observations, instrumen-

Figure 1: The official group photo is taken during the break of the talk by H.-J. Röser. From left to right in the first row: M. Billères, J. Dias, M. Van den Berth, A. Shaker, B. Wolff, I. Burud, M. Scodeggio. Second row: H.-J. Röser, T. Böhm, G. Meylan, M.-P. Véron, G. Jasniewicz, C. Boisson, L. Vannier, N. Przybilla, R. Kotak, A. Gonçalves. Third row: J. Kahanpää, R. Ibata, G. Marino, P. Woudt, G. Bergond, J. Vink, P. Kervella, S. Wolf, A. Zappelli, B. Parodi, Y. Momany.

tation, detectors, and data reduction. H.-J. Röser gave a comprehensive overview on imaging and photometry, with careful emphasis on how to avoid all classical pitfalls during observations as well as data reduction. D. Baade presented an equally useful presentation on low- and high-resolution spectroscopy. M. Dennefeld described optical and IR detectors, emphasising their physical processes and limitations, with present and future VLT instruments in perspective. P. Magain presented in a very clear way the subtilities and difficulties of deconvolution techniques applied to the process of data reduction. F. Rigaut gave a stimulating presentation of active and adaptive optics, the former technique being a must for the VLT meniscus monolithic 8.2-m mirrors, the later allowing to forecast major technological improvements in the near future.

On the final day, each group of students presented a summary of their results. Although the analysis techniques had, for the most part, just been learned, all groups presented interesting and in some cases potentially publishable results. This is no small achievement considering that most of them were entirely new to the scientific subject, the observing process, and the data analysis.

Sea & Space – A Successful Educational Project for Europe’s Secondary Schools

C. MADSEN and R. WEST,
ESO Education and Public Relations Department

1. Background

There are many links between the Sea and the Space surrounding us. Indeed, Space itself is often likened with a new and uncharted Ocean on which we now continue the great voyages of discovery of the past. Space-based satellites allow us to study the processes in the Earth’s oceans in unprecedented detail and at the same time to verify complex principles in fundamental sciences like physics, chemistry and mathematics. Space is also our tenuous link to the distant places from where the ingredients of life first came to our planet, and the ocean is where they began the incredible evolutionary processes of which we ourselves are a product.

With the goal to explain and illustrate some of these connections, an international educational programme entitled “Sea & Space” was set up under the auspices of the 1998 European Week for Scientific and Technological Culture. It was also linked directly to EXPO ’98, the World Exposition in Lisbon that focuses on the Oceans. The programme was primarily directed towards Europe’s secondary school students and their teachers. However, it was based on widely accessible communication links and was open for other interested persons and groups.

This was the fifth time since 1993 that ESO participated in this Week that is coordinated and supported by the European Commission. “Sea & Space” was a collaborative project between the European Space Agency (ESA), the European Southern Observatory (ESO), the European Association for Astronomy Education (EAAE), the German National Centre for Information Technology (GMD) and the Norwegian Space Centre. It drew upon the complementary scientific-technological and educational experience as well as organisational set-up of the partner organisations, including a great diversity of hard- and software and associated communication techniques. The programme was overseen by an International Steering Committee (ISC) consisting of representatives of each of the organisations, together with EAAE National Committees and other partners at the national level. Full information may be found on the web, e.g. at URL: http://www.eso.org/seaspace.

2. Contents

“Sea & Space” consisted of five major sub-programmes, three of which were heavily based on the use the World-Wide Web:

2.1 Remote Sensing of Europe’s Coastal Environment

Observations were made with the ESA Earth Resources Satellite (ERS) of coastal and other selected areas, some of these at the specific request by the participants. The data were suitably prepared and made available to the participants via the WWW, to enable the recipients to perform various computer-based exercises on the satellite data with special software packages and complement them with field measurements.

2.2 Navigation

With the help of carefully developed guidelines, the participants were able to determine their geographical positions in three different ways: by use of a variety of astronomical measurements using the Sun and the stars, with the Global Positioning System (GPS) and using satellite imagery. The participants could compare the results from the different methods and their uncertainties, providing them with fundamental insights into geodetic techniques and related areas, including technical and cultural aspects of important historical navigational feats.

2.3 "Oceans of Water"

There is water everywhere, not only on Earth, but also in space. Recent research has shown water to be present in much larger quantities than thought before, on the Moon, in the outer solar system, in the atmospheres of giant stars and in the interstellar clouds of dust and gas. This part of the "Sea & Space" programme was aimed at explaining the ubiquitous nature of this molecule that is so crucial for life on Earth. It gave the opportunity to introduce various interdisciplinary aspects (physics, chemistry, mathematics, geography, biology, astronomy) and to explain where there is water and how this precious resource influences the habitability of our planet, as compared to its sister planets, Mars and Venus.

2.4 The Contests

National competitions were launched among school pupils in the member countries of the European Union and of the partner organisations. Younger pupils (aged 10–13) made drawings/posters, while older participants (aged 14–18) prepared "Newspapers", working in small groups with their teacher(s). Typical subjects were "historical case stories from ocean navigation", "current methods of navigation on land and sea", as well as "reports on earth-observations by satellite". Informed speculations on parallels between the future exploration of space with new facilities, by remote sensing (e.g. ESO VLT) and *in situ* (e.g. ESA solar system missions), and the earlier ocean voyages, also found their way into the newspapers.

The European Week for Scientific and Technological Culture 1998

Sea & Space

Newspaper competition for School students in the United Kingdom!

Man has explored the Oceans for thousands of years. Now we are just about to begin the fantastic exploration of the Space that surrounds us. You are invited to produce your own newspaper about the continuing voyage of discovery. Join this competition and win a trip to the Expo '98, the World Exposition in Lisbon, where you will meet friends from all over Europe! Or win the Super-Prize that will take you to the ESA Spaceport in Kourou and to the site of the world's largest telescope, the ESO VLT!

We invite groups of young people of secondary school age to produce a newspaper on the theme SEA and SPACE.

The sea and space have much in common. Which links do you think are the most important ones?

You should look back and write about famous navigators, you should write about the current methods of navigation and you should look forward to developments hardly imagined. What was the role of water in ancient times? And today? Your team may also describe how you have used the data from the ERS satellite, made available over the WWW during the "Sea & Space" programme.

More information available at:

http://www.eso.org/seaspace
http://www.esa.int/seaspace
http://www.algonet.se/~sirius/eaae/seaspace

ORIZONTE

The competition was announced on the Web, and brochures were distributed to secondary schools in 16 European countries.

The winning posters by the 10–13-year-old children were put on display at the Gil Pavillon by the winning teams from the newspaper contest.

2.5 The Lisbon Event

The "Lisbon event" marked the final activity of the "Sea & Space" programme. It was organised in close collaboration with the other programmes within the 1998 European Week for Scientific and

Technological Culture, with the national first-prize winners of the Newspaper contest as participants. The event included presentations of the winning contributions as well as encounters with astrophysicists, ESA astronauts and others.

The presentations by the students took place at the Calouste Gulbenkian Planetarium. These presentations also formed the basis for awarding a “Super Prize” (a visit to the Kourou Space Centre and the VLT Observatory at Paranal) to the best team. This award went to a team from Blackrock College in Dublin, Ireland.

Finally, on Sunday 30 August, as part of the Sea & Space programme, a public presentation and discussion took place at the Sony Plaza of EXPO ‘98 with participation by scientists from ESA, ESO, the Max Planck Institute for Radioastronomy, a high-ranking representative from the European Commission and the Portuguese government, represented by the Minister for Science and Technology, Prof. J. M. Gago.

Prof. J.M. Gago, the Portuguese Minister for Science and Technology, in a lively discussion with the young Sea & Space participants at the Sony Plaza of EXPO ’98.

3. Outlook

Sea & Space was the first major web event that included Earth observations, and the contacts between ESO’s sister organisation, ESA, and EAAE constitute an important step in introducing Europe’s space programme and knowledge about remote sensing techniques to the schools. At the same time, Sea & Space was conceived with the purpose of conveying a clear message about our own position in space, i.e. an important aspect of modern scientific culture.

For the schools, the Sea and Space contests – in addition to being very useful for the development of interdisciplinary awareness – were also considered as vehicle for promoting the standing of the individual learning centres. It is apparent that this consideration is gaining increasing importance, as an element of competition finds its way into the European school system.

For ESO, the Sea & Space programme marked a natural continuation of the many-sided educational activities that – with the support by the European Commission – began at this organisation in 1993. They soon included a crucial 1994 conference that led to the establishment of EAAE, the European Association for Astronomy Education. Since then, many teachers engaged in astronomy education at various levels all over Europe have joined EAAE.

In addition to learning about new teaching ideas, methods and materials, they have also become much more aware of current astronomical activities, including many of those at ESO. New images and discoveries and frequent information about a wide spectrum of astronomical news, also from other sources, are rapidly disseminated among EAAE members who welcome this new service and regard them as useful educational tools.

The ESO-backed educational activities during the recent years are clearly seen as positive initiatives, not only by the participating schools, but also by the media and the national education authorities.

One of the important tasks of the ESO EPR Department in the near future will be to bring ESO’s VLT and the results that will come from this wonderful facility closer to educators and students. This may happen in different ways and requires input from professional astronomers and teachers as well as multi-media experts. A close collaboration between EAAE and ESO is now being set up to start this programme.

ANNOUNCEMENTS

List of New ESO Publications

Scientific Preprints

(June–August 1998)

1274. F. Comerón and P. Claes: Compact HII Regions in the Large Magellanic Cloud Observed by ISO. *A&A.*
1275. A.R. Tieftrunk, S.T. Megeath, T.L. Wilson and J.T. Rayner: A Survey for Dense Cores and Young Stellar Clusters in the W3 Giant Molecular Cloud. *A&A.*
1276. L. Pasquini and T. Belloni: Optical Identification of ROSAT Sources in M67: Activity in an Old Cluster. *A&A.*
1277. S. Savaglio: The Metal Absorption Systems of the Hubble Deep Field South QSO.
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Jean-Marie Mariotti (1955–1998)

Jean-Marie Mariotti, head of the VLTI programme at ESO since the fall of 1997, passed away at the age of 43 on July 28 in Munich, taken by a sudden and acute leukaemia. Together with his wife, Françoise, and their children, Appolline and Octave (6 and 3 years old), a brief ceremony was held on July 31 at the Ost-Friedhof in Munich, attended by his family and a number of his ESO friends and colleagues.

Jean-Marie was born in 1955 near Paris, from a family having Corsican and Italian origins. He first graduated in 1978 as an optical engineer from the Ecole Supérieure d'Optique at Orsay, the famous school that has given to optics and astronomy so many renowned characters. He then chose to move to astronomy and undertook graduate studies at the Université Paris VII. Thereafter he elected to sail on the risky and uncertain waters of high angular resolution at optical wavelengths, at a time when scepticism was dominant among many more classical astronomers. From his double training, Jean-Marie was to retain forever a constant preoccupation for clever experimental solutions and immediate applications to sound astrophysical problems.

Under the supervision of François Sibille, he defended a Doctorat de 3e cycle in 1981, on speckle interferometry in the infrared with observations collected at Zelentchuk and Kitt Peak, then after a short stay in Milan with P. di Benedetto, he joined the Observatoire de Lyon, which was at that time headed by Guy Monnet. With Christian Perrier just returning there from ESO, they built a long lasting collaboration and friendship which soon included Steve Ridgway. The Thèse d'Etat of Jean-Marie, presented in 1987 at the Université Claude-Bernard, sets out many results supporting the interferometry programmes of today, some of them obtained with the Plateau de Calern interferometer, the pioneering one at that time. He returned to the Observatoire de Paris in 1988 as an astronomer and his expertise, together with a firm but gentle temper, was soon internationally recognised: he chaired the ESO Interferometry Panel from 1990 to 1992, a key period for the detailed conception of the VLTI and its instrumentation; he became a member of the ESA Infrared Interferometry Cornerstone Advisory Group and of the NASA Planet Finder Science Advisory Group, two places where he played a key role in the emergence of the DARWIN mission. At the Observatoire de Paris, Jean-Marie supervised a number of students, among them Vincent Coudé du Foresto, Zhao Peiqian, Guy Perrin, Frederic Cassaing (ONERA), then, more recently, Bertrand Menesson, Cyril Ruilier and Pierre Kervella who will greatly miss him in the completion of their PhDs.

His exquisite understanding of coherent optics led to several basic interferometry articles: in 1984, with di Benedetto, he published a thorough analysis of pathlength stability in interferometers, from data obtained at the Plateau de Calern interferometer; in 1988, with Ridgway, he invented the Double Fourier spectral-spatial analysis which elegantly extends to a spatial interferometer the classical Fourier spectroscopy. Both of these, along with Fizeau's, Labeyrie's and Shao's papers, are included in the elite collection of Selected Papers on Long Baseline Stellar Interferometry, published by Lawson in 1997.

In fact, a third article in this selection, although not signed by the ever modest Mariotti, was in 1991 a capital contribution which he inspired and made effective: it develops the concept of spatial filtering, with optical fibres, of the optical beams affected by atmospheric turbulence. Applied by Coudé du Foresto and Perrin since 1992, this leads to a gain of an order of magnitude in accuracy of interferometric visibilities, reaching nowadays 10^{-3} or better. The impact on stellar physics has been immediate, leading to unprecedented accuracy on effective temperature of stars. All interferometers planned today, including VLTI and Keck, will use this concept. Elaborating on the expected or demonstrated performances of optical fibres, he proposed in 1996 a futuristic view where the large telescopes present on the Mauna Kea site could be coherently coupled with the same convenience as radio astronomers carry coherent signals on kilometric distances.

His contribution to astronomy began in 1983 with careful speckle observations of circumstellar envelopes, including objects such as GL2591 IRC+10216 or MWC 349. The mastery he and Perrier had attained in speckle interferometry and understanding of the capricious atmospheric turbulence led them to publish in 1987 a paper which had to question the reality of the "first" brown dwarf, VB8 B, proposed to be a companion to the star VB8. Indeed this rather negative task was unpleasant, but later independent observations supported the conclusion. It was the beginning of Jean-Marie's interest for low-mass objects, such as brown dwarfs. This would lead him, in collaboration with the late Duquennoy in Geneva, to systematic surveys in both hemispheres, utilising adaptive optics and still waiting for completion.

The issue of exo-planets and possible life was associated in Jean-Marie's mind, as it is among many astronomers, with fundamental questions on the place of Earth and man in the Universe. This philosophical rooting, where he felt some ethical obligation for his profession, certainly played a role in his ever deeper involvement in the subject: he was at the origin of the Darwin interferometer proposal to ESA, he refocused the VLTI on the detection of exo-planets and, finally, he discovered jointly with Mayor, Perrier and others, a jovian-type planet at 2.5 a.u. from the star 14 Her, only a few weeks before his passing away.

Jean-Marie was highly conscious of the need to train a new breed of astronomers, especially in Europe, in these revolutionary perspectives of optical interferometry and the search for exo-planets: together with Danielle Alloin, he organised three schools in Cargèse (1988, 1993, 1998) and published books which are references for a whole generation.

We will all cherish his memory and deeply miss this friend, this colleague who had mysteriously retained in the sometimes muddy waters of scientific competition the candour of an intelligent child and the humorous smile of a quiet philosopher.

Pierre Léna

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1289. F. Bresolin, R.C. Kennicutt, Jr., and D.R. Garnett: The Ionizing Stars of Extragalactic HII Regions. *Astrophysical Journal*.
1290. D. Baade: Nonradial Pulsations of BA Supergiants and Be Stars. Invited talk given at IAU Coll. 169 "Variable and Nonspherical Stellar Winds", Heidelberg, June 15–19, 1998, eds. B. Wolf, A.W. Fullerton and O. Stahl.
1291. M.F. Sterzik and R.H. Durison: The Dynamical Decay of Young Few-Body Stellar Systems. I. The Effect of a Mass Spectrum for N = 3, 4, and 5. *A&A*.
1292. K. Iwamoto et al.: A 'Hypernova' Model for SN 1998bw Associated with Gamma-Ray Burst of 25 April 1998. *Nature*.

Scientific Report

Scientific Report No. 18 – June 1998: "A Catalogue of Quasars and Active Nuclei (8th Edition)." Edited by M.-P Véron-Cetty and P. Véron.

PERSONNEL MOVEMENTS

International Staff (1 July – 30 September 1998)

ARRIVALS

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HILL, Vanessa (F), Fellow
DUNCAN, Douglas (USA), Associate, Office for Science
VAN BEMMEL, Ilse (NL), Student
AMICO, Paola (I), Astronomical Data Quality Control Scientist
HANUSCHIK, Reinhard (D), Astronomical Data Quality Control Scientist
CRISTIANI, Stefano (I), Associate, Office for Science
FARINATO, Jacopo (I), Associate, Support Engineer to the Adaptive Optics Group
RAUCH, Michael (D), User Support Astronomer
CURRIE, Douglas (USA), Associate, Support Engineer to the Adaptive Optics Group
FYNBO, Johan (DK), Student

ESO, the European Southern Observatory, was created in 1962 to "... establish and operate an astronomical observatory in the southern hemisphere, equipped with powerful instruments, with the aim of furthering and organising collaboration in astronomy ..." It is supported by eight countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Sweden and Switzerland. ESO operates at two sites. It operates the La Silla observatory in the Atacama desert, 600 km north of Santiago de Chile, at 2,400 m altitude, where fourteen optical telescopes with diameters up to 3.6 m and a 15-m submillimetre radio telescope (SEST) are now in operation. In addition, ESO is in the process of building the Very Large Telescope (VLT) on Paranal, a 2,600 m high mountain approximately 130 km south of Antofagasta, in the driest part of the Atacama desert. The VLT consists of four 8.2-metre and several 1.8-metre telescopes. These telescopes can also be used in combination as a giant interferometer (VLTI). "First Light" of the first 8.2-metre telescope (UT1) occurred in May 1998. UT1 will be available on a regular basis for astronomical observations from April 1999 on. Over 1000 proposals are made each year for the use of the ESO telescopes. The ESO Headquarters are located in Garching, near Munich, Germany. This is the scientific, technical and administrative centre of ESO where technical development programmes are carried out to provide the La Silla and Paranal observatories with the most advanced instruments. There are also extensive astronomical data facilities. In Europe ESO employs about 200 international staff members, Fellows and Associates; in Chile about 70 and, in addition, about 130 local staff members.

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SANSGASSET, Pierre (F), Mechanical Engineer
PETR, Monika (D), Fellow

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DUC, Pierre-Alain (F), Fellow
KROKER, Harald (D), Fellow
LUCY, Leon (GB), HST Scientist
PITTICHOVÁ, Jana (SK), Student

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