1997 June VLT Test Cam #1
FIERA with thinned chip (2k × 2k + tracker chips). We may need to deliver this system earlier.
1997 July UVES
FIERA blue arm (2k × 2k eng. grade device).
1997 September SUSI-2
FIERA with UV-sensitive 4k × 4k (two 2k × 4k devices).
1997 September NAOS
FIERA with AO chip (128 × 128), plus spare system (thermo-electrically cooled dewar).

1998 January UVES
Upgrade blue arm to science grade, deliver red arm 2k × 4k (single chip or mosaic of 2k × 2k), plus spare parts. If possible, we will deliver the red arm with the long-term goal of a 4k × 4k mosaic. In addition, the blue arm may be outfitted with a new generation 2k × 4k device.
1998 March FORS 2
FIERA with Tek/SITe 2k × 2k.
1998 March FUEGOS
FIERA with eng. grade 4k × 4k (two 2k × 4k chips).
1998 December VLT Test Cam #2
FIERA with thinned chip.

1999 March FUEGOS
Put science grade devices into system.

The ESO community should note that we are taking the position that all new CCD controllers on the VLT and new ones on La Silla (under ESO maintenance) will be FIERA systems. We take this stance because we have the responsibility to maintain all optical detector systems. In addition, ESO instruments should get the benefit of the advanced capabilities provided by FIERA. (This statement does not include the new system at the Danish telescope or FEROS, since FIERA will not be available until 1997.)

9. One Observatory – La Silla and Garching

The ODT has made great strides in improving communication between Garching and La Silla. One aspect is weekly video conferences on every Thursday. In addition, we plan for more personnel exchanges – at least one visit per year of each member to the other site for functional work. Also, all large development projects are now a shared concern, both for design and for maintenance – no more dichotomy of developing in Garching and giving to La Silla for maintenance.

FIERA is a first big step in this area. The second step we have taken is a "universal" temperature/vacuum sensing & temperature control box that will be used with VME, ACE and FIERA systems. This system is being developed in La Silla with interaction by Garching staff.

The third design area where we are combining efforts is a new CCD detector testbench. All members of the ODT will contribute to design and critique the development as it progresses in 1996.

10. Communication with the ESO Community – World Wide Web

We have taken the approach that the World Wide Web is the best avenue for communicating information to the ESO user community. A new, clearer and more concise presentation of data about ESO's CCD devices went on-line in the beginning of September 1995. Besides providing standard data, we use this medium for user requests. This information will continue to evolve as we receive comments and constructive criticism about the content and format. Please assist us with continual improvement.

11. Facilities

A new facility upgrade planned for 1996 is the design and construction of a new CCD testbench. With an increased number of new detectors and the old testbench dependent on the VME controller, Garching (and perhaps Chile) needs a new testbench. To be operated by the FIERA controller, the testbench will utilise the knowledge gained from the many years of experience with the present CCD testbench.

We are also developing an optical set-up to scan a 2 micron wide (minimal wings) spot of variable wavelength across the pixels of CCD devices. We will use this apparatus to measure the diffusion of photoelectrons that causes degradation of PSF in CCD devices. PSF degradation was an unwelcome surprise during the CES upgrade and we must become expert at measuring this behaviour for all of our CCD chips. High quality PSF is important for nearly every application, but especially so for adaptive optics and high-resolution spectroscopy.

12. Optical Detector Workshop – October 8-10, 1996

The ESO CCD workshops held in 1991 and 1993 were valuable venues of information exchange about astronomical CCD detectors. After a brief respite, ESO will continue the series with an Optical Detector Workshop to be held during October 8–10, 1996 in Garching. The attendance of the workshop is being limited due to space constraints and our desire to create an intimate setting for information exchange. We have received confirmations of attendance from most of the leading manufacturers and major observatories. (If you wish to attend, please submit a request to jbeletic@eso.org)

13. Closing Comments

The optical detector team has established a coherent plan of activities for improving ESO's technology in this critical area. Our mission is to develop, implement and maintain optical detector systems that are the best that science and technology can provide. We encourage feedback on the direction and plans that we present in this report.

(Please send comments to: jbeletic@eso.org or odteam@eso.org)

Pointing and Tracking the NTT with the "VLT Control System"

A. WALLANDER, F. BIANCAT MARCHET, M. CHIESA, P. GLAVES, D. GOJAK, M. NASTVOGEL-WÖRZ, R. PARRA, T. PHAN DUC, R. ROJAS, J. SANTANA, J. SPYROMILIO, K. WIRENSTRAND, ESO

Introduction

One of the three main goals of the NTT Upgrade Project is to test the VLT control system in real operation before installation on Paranal. Although NTT and VLT have large differences in optics, mechanics and electronics, the VLT Common Software and the standardisation of VLT control electronics provide a common base. The strategy of the NTT Team has been to develop NTT unique

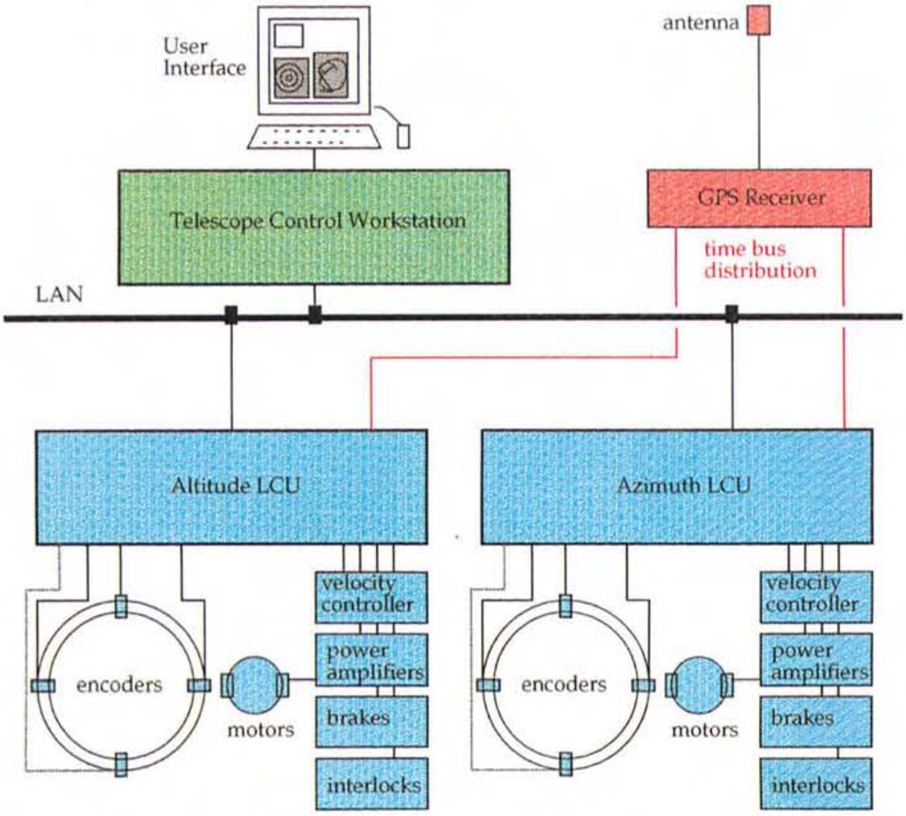


Figure 1: System Block Diagram.

applications on top of this common base and field test them on the telescope subsystem by subsystem, thereby providing feedback to the VLT development and preparing for the NTT Big Bang.

Lately, with the advancement of VLT applications as well as moving to more complex and higher level NTT applications, the common base of NTT and VLT has been found on an even higher level. The heart of TCS, pointing and tracking of the telescope, is an example of this. The design, development and test of this subsystem has been performed in close collaboration between VLT TCS group and NTT Team, with the aim of having nearly identical systems for NTT and VLT. Such an approach does not only make optimal usage of available resources, but even more important, allows a thorough testing of the control system before first usage at Paranal. The resulting application code, sitting on top of the VLT Common Software, comprises of about 75,000 lines of C and C++ code of which 50 % are comments.

Differences between the two telescopes, mainly interfaces to hardware and other subsystems, have been isolated in the code. With techniques of compilation flags, subclasses and a dedicated module per telescope defining installation procedures and configuration parameters (e.g. site location), the target telescope is specified at installation time. Thus an installation consists of checking out the standard modules from the software archive and executing an installation script unique per telescope.

The pointing and tracking of the telescope was subject of a NTT field test the first ten days (nights) of December 1995. As for all previous field tests the strategy was to replace workstations, hardware and software, execute the test, and then restore the original system. In addition to the change of VME boards and I/O wiring two major hardware changes were required. The VLT GPS based timing system replaced the old Cerme clock required for tracking, and all electronics processing the data from the encoder heads were replaced. To use the limited available test time as efficient as possible, a large number of staff working in shift participated, and a detailed test plan and formal reporting kept the activities under control.

System Architecture

Three application modules, written in C++ and based on the event handler delivered with the JUL95 release of VLT Common Software, are running on the workstation. These modules mainly have administrative responsibilities in performing system start-up and shutdown, providing hooks for user interfaces, providing interfaces to other subsystems, and forwarding requests to tracking axes. Examples of the latter are preset and offset requests and pointing modelling and meteorological data (temperatures, pressure and humidity) required by tracking. Data for status displays and alarms are generated using the CCS scan system, mirroring part of the LCU databases on the workstation database. In addition to standard VLT engineering user interfaces, prototypes of TCS GUI's, developed using the panel editor, provides the interface to the user. We believe it is important to involve the final users, in this case the telescope operators, as early as possible in this area.

A telescope preset request from the GUI results in commands sent to all configured tracking LCU's. During this test only altitude and azimuth were included, but in a final system the rotator in the active focus station will also be included. From here on the LCU's can operate autonomously by having the reference co-ordinates, expressed in right ascension, declination and epoch, and the sidereal time obtained from the time bus.

The GPs receives time information via an antenna mounted on the roof of the building and distributes absolute universal time to the tracking LCU's via the fiber optic time bus.

The two main tracking axes, altitude and azimuth, comprise encoders, velocity controllers, power amplifiers, brakes, and interlock sensors. This hardware is controlled and monitored from a VME based LCU with standard VLT I/O boards and drivers. The application software in the LCU, written in C and based on LCC delivered with the JUL95 release of VLT Common Software, is responsible for interfacing the hardware and performing position control. Having received the reference co-ordinates and the time bus signal, the tracking application calculates every 50 ms the required absolute position of the axis using *slalib* (a widely used library, developed by Pat Wallace, for astronomic position, time, and co-ordinate conversion calculations). This value is forwarded to the position controller which uses linear interpolation to produce new reference values for the velocity controller, implemented in hardware, every 2 ms.

The altitude and azimuth encoder systems are completely different for VLT and NTT. Nevertheless, it was decided to replace the existing NTT encoder interpolation electronics with a newer generation from the same supplier used also by Telescopio Nazionale Galileo. Identical systems will be used for the VLT rotators. The new generation interpolation electronics increases the theoretical resolution by a factor 4 (smallest detectable change of angle is less that 0.01″), allows a faster read-out (position control loop speed can be increased from 5 to 2 ms), is more compact, and provides a cleaner interface to the software.

Results

As was expected beforehand, most problems were encountered with the encoder handling. This part could not be tested in the lab due to lack of similar hardware. During the test, firmware

Figure 2: VLT/NTT TCS "First Light "December 1995.

problems were discovered, which prevented the use of all four encoder heads, and in order to proceed with the test it was necessary to operate in a degraded mode using only one of the four encoder heads. These problems shall now be resolved together with the supplier.

At the early stages of the test engineering tools delivered with VLT Common Software were extensively used. The tools inducer and lcudrvTk, which allows the engineer to access and exercise the VME boards directly, made it possible to identify and solve many problems related to the hardware. The sampling tool, which allows sampling and real-time trending of signals at 20 Hz, was absolutely essential when tuning the position control loops.

On the 7th of December the first attempt was made to track on the sky. The telescope operator Jorge Miranda pointed to a bright star, and the guide probe video monitor was switched on. After some pointing model parameters were adjusted the star appeared on the screen and stayed in the same position. Figure 2 shows the reaction of the testing crew at this moment.

In order to verify as much performance and functionality as possible, a script was written using the VLT sequencer, to write star trail characters on the sky using offsets and differential tracking. It should be noted that this test also demonstrated the power and simplicity of the sequencer scripting language. The resulting CCD image is shown in Figure 3. This exercise showed a serious problem, clearly visible on the image, of tracking stability. There appears to be a low frequency (< 0.2 Hz), approximately 1.5 arcseconds peak to peak, tracking error. The same behaviour was confirmed during normal tracking. Unfortunately, the remaining test time did not allow an extensive investigation of the problem. Data for off-line analysis were obtained, but it is believed it will be very difficult to find a solution without having access to the telescope. On the other hand, we are confident that the cause and a solution can be found quickly at the beginning of the NTT Big Bang. Note that the old control system does not exhibit this behaviour and was tested extensively during the handover back to normal operation.

Figure 3.

Conclusion

Considering the limited amount of telescope time and the complexity of the test, we consider it to be a major step towards the NTT Big Bang and VLT commissioning.

The experience obtained will be very valuable for the ESO test period of the VLT main structure in Milan. Later, it will become a tremendous advantage during commissioning of the VLT at Paranal, when a large part of the control system has already been in operation at the NTT for more than one year.

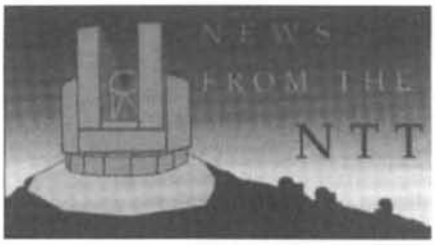
At the same time we still have to solve some of the problems encountered, mainly encoder handling and tracking stability, as well as implement missing functionality and fine tune the system. It should also be remembered that the step from operating a system with experts present to routine operation can be rather large.

Acknowledgements

We like to acknowledge the major contributions to the system described of the following VLT staff. Martin Ravensbergen for the timing system and position control, Bruno Gilli and Norbert Fiebig for

the software position control module, Gianluca Chiozzi for the preset module and everything related to object oriented design and C++, and the rest of the staff in VLT/ELE department for VLT common software and VLT electronic standards. We also thank Rolando Medina for installing the antenna and fibres for the VLT timing system in advance of the test.

E-mail address: awalland@eso.org
(Anders Wallander)



The NTT upgrade project has the following goals:

1. *Establish a robust operating procedure for the telescope to minimise down time and maximise the scientific output.*
2. *Test the VLT control system in real operations prior to installation on UT1.*
3. *Test the VLT operations scheme and the data flow from proposal preparation to final product.*

J. SPYROMILIO, ESO

This issue of *The Messenger* is the last before the NTT upgrade project goes into phase II (the Big Bang) of the upgrade. In July this year the NTT will go off-line to install the VLT control system on the telescope. Many people ask me why the NTT is going off-line for a whole year for a change in the control system. This appears to a number of people as a disproportionate length of time. The modifications to the NTT are not limited to the telescope itself. Every subsystem of the NTT is upgraded to VLT standards from the building and hydraulics to the target acquisition systems. The slow read-out electronics for the CCDs are also being upgraded to the ACE system which should cut down the read-out times dramatically. In addition the supporting systems such as scheduling, phase 2 proposal preparation tools, automatic data reduction are being upgraded as well. Alignment procedures and tools for the VLT are also being tried out during this period.

The NTT team fully appreciates that removing a resource as valuable as the NTT from the community for any length of time is painful. The astronomers within the team are also active users of the telescope and will also suffer the withdrawal symptoms. However we firmly believe that for every month that is expended on the NTT now, we shall gain a month on the VLT UT1. This does not only apply to the software and hardware installations but also to the operation of the VLT as a scientifically useful telescope. The transition from a facility that works to one that produces science is often long. The NTT project as a test bed for VLT operations aims to cut this transition time down to a minimum for UT1.

Operational News

The statistics for 1995 are in. The NTT had a total down time of less than 48 hours in 1995. This is 2.1% of the time available for observing and puts us at the bottom of the published results for 4-m-class telescopes. In this case being at the bottom is the best position to be in. This number has been achieved by a number of ways. First and foremost the dedication of the operational staff. Preventive maintenance also plays a big role. The NTT has a maintenance plan which details the activities of the team every day of the year. Operations have been moved from the minds of individuals to documents and check lists. The NTT runs according to a plan and this transparency of operations minimises the time lost due to mistakes.

Unfortunately, some bad news have also to be reported. The sensitivity of EMMI has dropped significantly. Preliminary investigations indicate that some of the very sophisticated coatings of the EMMI optics which had reflectivities as high as 98% have aged more rapidly than expected. The problems are being further investigated as this article is written and the latest EMMI sensitivities will be published on the Web. The recoating of the elements is not an operation that can be undertaken on very short timescales. However, every effort to recover the nominal sensitivity is being made.

Progress with Big Bang Preparations

On page 7 of this issue of *The Messenger*, a detailed description of the first test of the VLT Telescope Control System can be found. However it is appropriate here to say a few words about the significance of this field test. In the past the NTT team has tested a number of subsystems of the control system to be installed during the big bang. However, the TCS test can fairly be described as the biggest challenge for the VLT software to date. Problems were found during the test but no show stoppers. In the article describing the details of the test, an image where the NTT was made to write "VLT" on the sky is shown. Although this image showed a problem with the tracking in the new system, I am confident that this problem will be solved. It should be noted that this image was created by using a very large number of functions of both the new TCS and the VLT control system. The image was generated by using the differential tracking and offsetting modes of the new TCS and was run in a completely hands free mode. A script for the higher level operation software (also known as the sequencer) was written in a few minutes in the scripting language for the VLT. The script was executed at the workstation level, and the actual movement of the telescope was performed by two independent local control units synchronised by the VLT standard absolute time reference system.

The importance of the sequencer in the VLT style operations cannot be overstated. The sequencer is the primary communications tool between the outside world and the VLT control software. It makes possible the co-ordination of the telescope, instrument and detector control software.

As the article is being written, the author is on La Silla watching the EMMI instrument being controlled by VLT standard instrumentation software and electronics. These results give great confidence that baring unforeseen problems we expect to be ready for the big bang in time.

E-mail address: jspyromi@eso.org
(Jason Spyromilio)