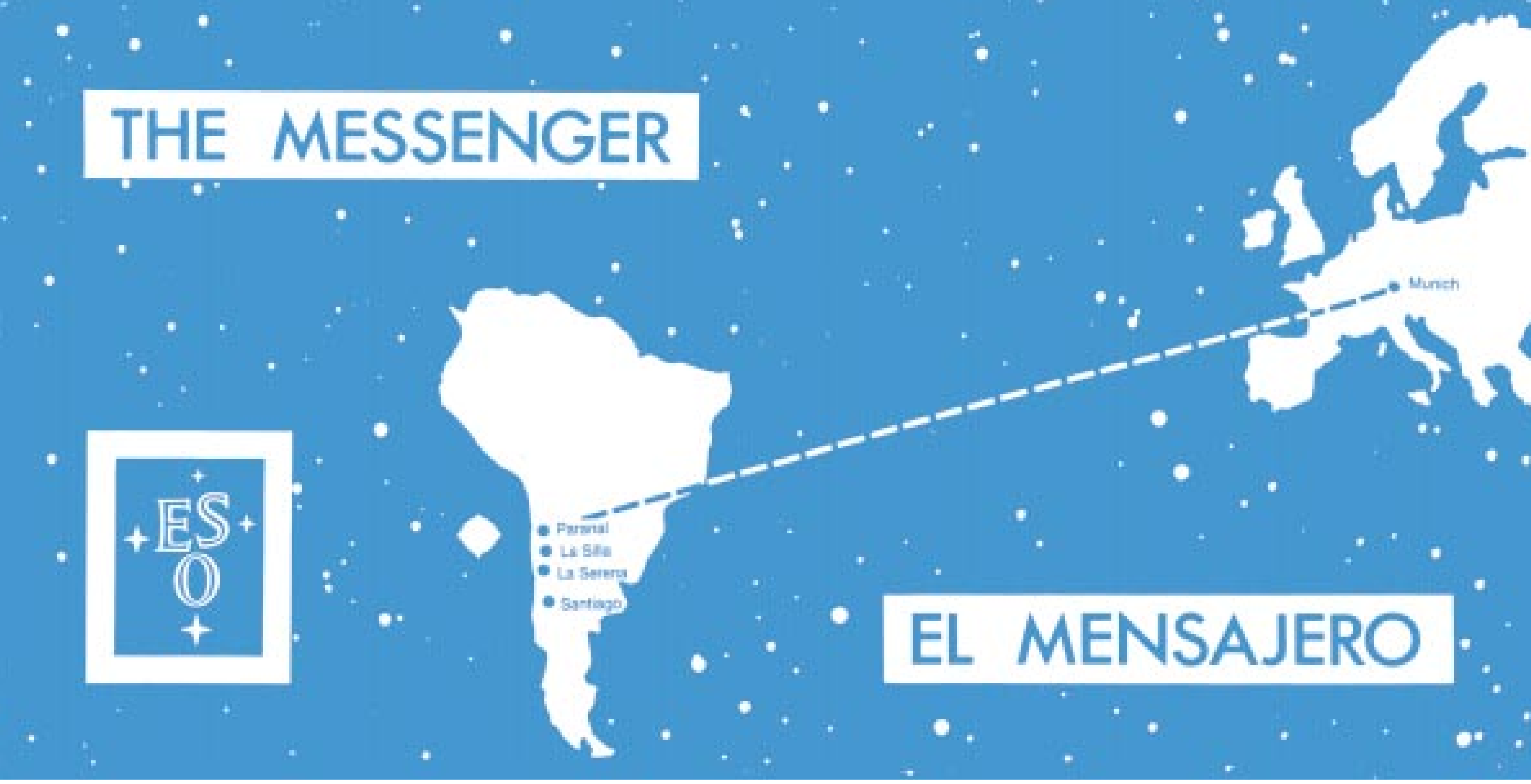

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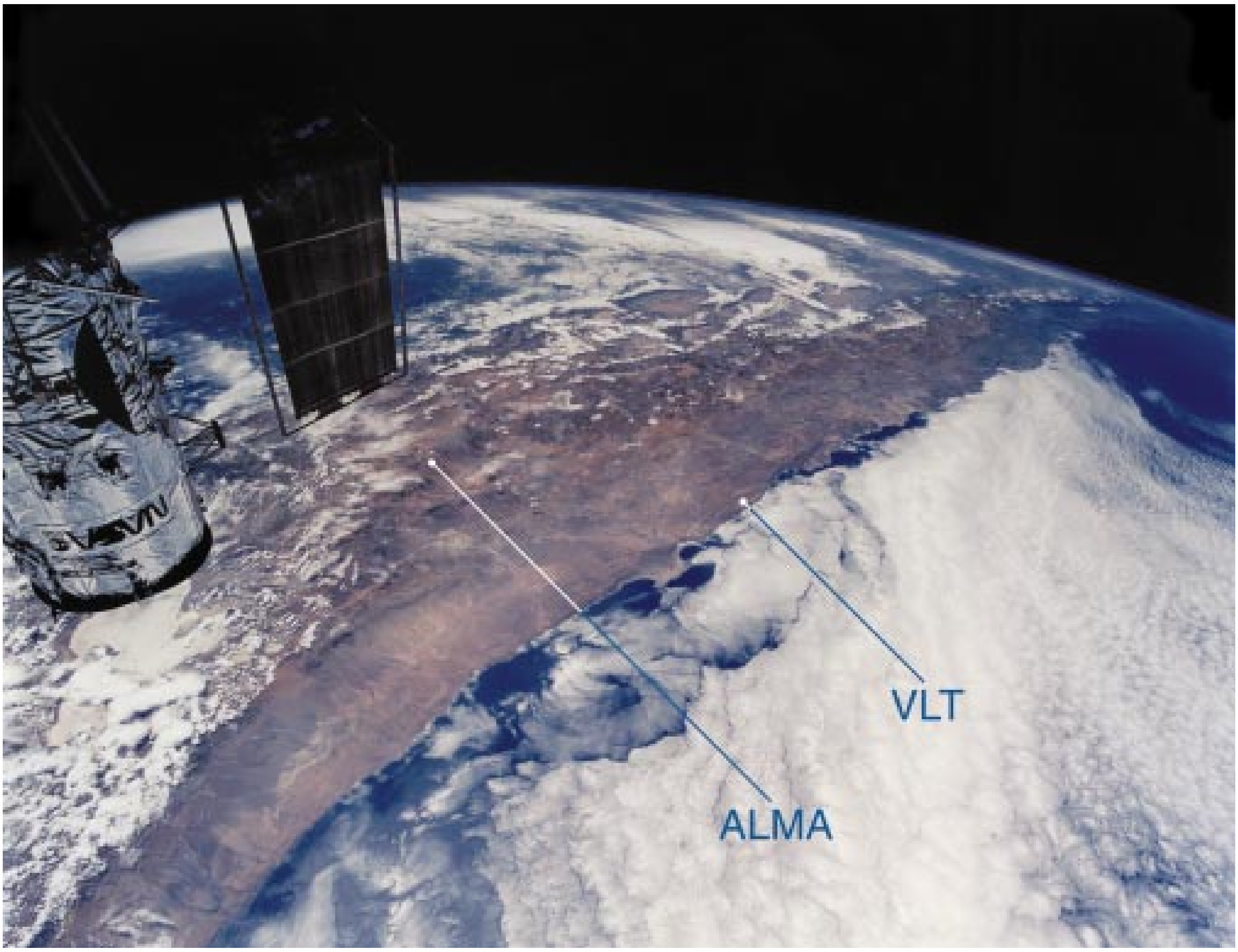


***View of Northern Chile**, as seen from the NASA Space Shuttle during a servicing mission to the Hubble Space Telescope (partly visible to the left). The Atacama Desert, site of the ESO VLT at Paranal Observatory and the proposed location for ALMA at Chajnantor (see article on page 7 in this issue of The Messenger), is seen from North (foreground) to South. The two sites are only a few hundred km distant from each other. Few clouds are seen in this extremely dry area, due to the influence of the cold Humboldt Stream along the Chilean Pacific coast (right) and the high Andes mountains (left) that act as a barrier. Photo courtesy ESA astronaut Claude Nicollier.*

Introduction to the ESO Annual Report 1998 by Prof. Riccardo Giacconi, Director General of ESO

1998 has been a banner year for ESO. Success has crowned the dedicated effort of the entire staff in a number of endeavours of the highest significance for European astronomy.

The First Light obtained on May 25 at UT1 (the first of the VLT 8-metre telescopes on Paranal to be completed) represents the culmination and validation of years of engineering and technical development of the active thin meniscus telescope mirrors pioneered by ESO. The stunning results obtained in the very first few weeks of commissioning show that the essential technical issues have been mastered and this fact has allowed us to proceed quickly to science verification and scientific use of the telescope by the community. This is a great achievement for European research and European industry.

1998 also saw the commissioning of the first two focal plane VLT instruments intended for scientific use. FORS and ISAAC made a very successful debut. The first is an imager and multi-object spectrometer provided by a consortium of German Astronomical Institutes (Heidelberg State Observatory and the University Observatories of Göttingen and Munich), the second an infrared imager spectrometer built at ESO, the only instrument of its kind in service at any large telescope in the world. The co-operation with the European research community, which has taken primary responsibility for 9 out of 11 VLT instruments, is proving to be an important element in fully utilising the best instrumentation talents in Europe. The combination of academic creativity and ESO quality control seems to provide a good assurance of success of frontline instruments built at reasonable costs.

The development at ESO of advanced detectors for the optical and the infrared has succeeded in producing systems that are world class. These systems are incorporated in almost all ESO's instruments. The instrumentation programme for second-generation instruments on the VLT is getting under way.

It is worth noting that the VLT programme has proceeded on schedule and within anticipated costs. We fully expect to complete it as planned.

The VLTI programme also saw very significant progress during the year. The construction of the delay lines, auxiliary telescopes and instruments for interferometry is well under way with first fringes expected in 2001.

Equally important for the European astronomical community are the achievements of the La Silla Observatory where the refurbishment and upgrading of all the telescopes is essentially complete. First Light was obtained with SOFI (an infrared imaging spectrometer similar to ISAAC) at the NTT, with FEROS (a broad-band spectrometer) at the 1.5-metre telescope and with the 8k × 8k wide field camera at the 2.2-metre MPG/ESO telescope. La Silla has, in the past few years, increased substantially its effectiveness, modernised its facilities and become the most scientifically productive observatory in the world in terms of publications in refereed journals.

Using observations of distant supernovae obtained with La Silla telescopes, as well as other telescopes available to their colleagues at other institutions, ESO astronomers have actively contributed to the work of the international team that obtained the most startling discovery of 1998, namely that the expansion of the Universe is accelerating.

The ESO methodology for providing facilities to the astronomical community has shifted more and more toward an end-to-end science approach. Software tools are furnished for proposal preparation, observations planning, calibration, pipeline data processing and archiving for essentially all major ESO facilities. An important achievement of 1998 has been the realisation of the unified HST/VLT archive. Carried out as a collaboration between ESO and the ESA-ESO ECF, this development has resulted in a powerful and unique tool for astronomical research.

Finally the ESO Council and Executive have taken important steps in assuring the future of ESO contributions to European Astronomy. The Council unanimously endorsed the vision of ESO embodied in the Document "ESO's role in European Astronomy", which was published in *The Messenger* No. 91 of March 1998. The Council also approved the Executive's proposal for ESO involvement in the first phase of development of the LSA/MMA [now called ALMA, the editor] sub-millimetre wave array jointly with the USA. The LSA/MMA array will be the largest and most powerful submillimetre/millimetre-wave interferometer in the world, with the potential of unique and crucial contributions to the study of some of the astrophysical problems of greatest current interest.

A Memorandum of Understanding between ESO, PPARC, CNRS, MPG, NFRA/NOVA was signed on December 17, 1998. A European Co-ordinating Committee and a European Negotiating Team were created following the provision of this MoU enabling the European partnership to initiate detailed technical discussions and negotiations with NRAO, AUI and NSF. Joint discussions with Japanese astronomers are underway to extend this partnership to a worldwide project.

For a more distant future, the ESO-STC has endorsed the proposal for a study phase of the feasibility of a new 100-metre-diameter filled-aperture telescope that will represent the next step in ground-based optical astronomy. Technical and industrial studies are getting underway at the beginning of 1999.

These achievements are a matter of considerable pride for all of us at ESO. We recognise with gratitude the constant support of the ESO member state nations which made this possible.

Inauguration Ceremony of Paranal Observatory – 5 March 1999

Discourse of Prof. Riccardo Giacconi, Director General of ESO

President Frei, Minister Arellano, Ambassadors, Ministers, President of the ESO Council, Council members, Intendente of the II Region, Civilian and Military Authorities, Distinguished Guests, Ladies and Gentlemen,

It is a great joy for all of us at ESO to welcome you here for this ceremony which represents the culmination of years of effort to build what will be the largest array of optical telescopes in the world.

April 1st will see the start of the science operations with the first 8-metre telescope. During this last week, astronomers from all over the world have been discussing in Antofagasta the optimum scientific use of the very large telescope.

Tonight you will hear President Frei, and the President of the ESO Council, Mr. Grage, discuss the meaning they associate to this event, Prof. Carlo Rubbia will speak later of its meaning for science.

I will limit my remarks to the perspective of all of us at ESO, who have been working for many years to bring this project to fruition. To be associated to such a historic undertaking during one's professional career is a rare and wonderful privilege, for which we are all grateful.

Many things can be said about such an adventure, but perhaps the most striking feature of the development of this great machine, which we carried out together with the astronomical and industrial communities of Europe and Chile, has been the striving for excellence in all its different aspects.

The European companies involved in the construction of the VLT include Schott, REOSC, GIAT, Ansaldo, Dornier, Zeiss, Soimi, Amos, Fokker, EIE, ETEL and many others too numerous to mention. They succeeded in developing advanced technology in the many disciplines required to meet our stringent specifications. They succeeded in doing so on time and within fixed budgets.

They have reached a level of performance in the execution of this project that has made them competitive in the field of large optics, world-wide.

In effect, we have done again what George Ellery Hale advocated when he built the 5-metre telescope on Mt. Palomar, that is, to use the best of the available industrial capacity at any one time to build the most refined scientific instrument for astronomy. How much better to use our industrial might to advance knowledge and the human spirit, rather than to produce machines for destruction.

Although the success in technology brings many important benefits, in terms of the acquired experience and know-how, and in terms of industrial competitiveness and image, yet the most important motivation for us to build these great machines is that by doing science with the VLT we will be able to explore the most remote epochs of the universe, when it was only a mere fraction of its present age and when the first structures were forming and beginning their slow evolution into galaxies, stars and planetary systems. To communicate what this means to an astronomer, I can find no better words than those of Milton: "Before (his) eyes, in sudden view appear the secrets of the hoary deep – a dark illimitable ocean, without bound, without dimension..."

We will join in friendly competition in the voyage of discovery initiated with the Hubble Space Telescope and Keck. When the full array of the four major telescopes, as well as the auxiliary outriggers are completed we will achieve, by use of adaptive optics and interferometry, the ability to study details of the cosmic sources, 30 times finer than hitherto achieved, even in space missions. We will be able to ask even more penetrating questions on the formation of stars and galaxies, on the dynamic processes within them, and on the existence of planetary systems capable of sustaining life.

The great telescopes and instruments you see before you are but a part of the science machine we have built. Sophisticated computer technology is used through the system. Software tools are provided to the astronomers for the formulation of the observing programmes, the planning of the observations, the accumulation and calibration of the data and, finally, their quality control and archiving. In these aspects of our work pure technology is transcended, to become the scientific methodology necessary to address the sophisticated questions of greatest current astrophysical interest and to achieve excellence in science.

As we carry out this challenging work we gain experience, self-confidence and pride in doing an interesting and difficult job as well as we can. It is satisfying to achieve maximum scientific results within the available means. It is wonderful to design new systems and see them come about and work as desired. As we do these things we change, and our organisation also changes.

The degree of professionalism shown by the engineering, technical and scientific staff at ESO, both international and Chilean in this project, has few precedents in the history of astronomy.

In carrying out the VLT project, ESO as an organisation has had to change and mature. While we were able to capitalise on technical ideas and experience accumulated over many years, the sheer size of the project demanded that we develop new management approaches and new methodology to cope with its complexity. Having successfully overcome these challenges we feel quite confident that we will complete the current tasks while already planning for the next generation of telescopes.

We feel a deep desire to share our knowledge and achievement with the public at large and, in particular, with the young people. It is, after all, they who will use the VLT for years to come and will experience the thrill of new discoveries.

As in the time of Copernicus, Galileo and Kepler, it may take decades, or even centuries, for the profound implications of scientific discoveries to become translated in our vision of the world and of our place in it, as part of the general culture.

For now, we can only start this long-range process, which is sure to occur, by undertaking educational programmes in Europe and Chile.

Here, in Chile, the Comité mixto Chile-ESO has initiated last year. Its mission to support astronomy development at the university level.

In the local communities, we helped teachers involved in science education and we would like to engage the imagination of the children of the II Region, and make them happy to have the VLT here.

We have recently fulfilled our promise to President Frei, to let the school children of the II Region name the telescopes. We have carried out a competition which has resulted in very poetic and appropriate names for the four 8-metres. The names in Mapuche are:

Antu (the Sun), Kueyen (the Moon), Melipal (the Southern Cross) and Yepun (Sirius).

I was particularly struck by a sentence used by the school student to explain why the choice:

*Todas estas palabras están relacionadas con la luz y para mi la luz significa paz y vida. Seguida de la idea de que todo tiene relación con el universo.**

Prof. R. Giacconi with the17-year old Jorssy Albanez Castilla from Chuquicamata near the city of Calama, winner of the essay competition, in which schoolchildren of the Chilean II Region were invited to write about the implications of the names given to the four VLT unit telescopes. She received the prize, an amateur telescope, during the Paranal Inauguration.

*(Note from the Editor: Quote from the student: *All these words are related to light, and for me light means peace and life. This follows the idea that everything is related to the universe.*)

Discourse of Mr. Grage, President of the ESO Council

Your Excellency the President of the Republic Don Eduardo Frei Ruiz-Tagle and Mrs. Martita Larraecheade Frei, Minister Arellano, Minister Guerzoni, Ambassadors, Heads of Delegations and Council Colleagues, Prof. Rubbia, Director General, Members of Parliament, Authorities from Antofagasta and Taltal, Distinguished Guests,

I am very happy to welcome all of you at the site of the ESO Very Large Telescope Array, the Paranal Observatory. I can imagine that, as I, all of you are thoroughly impressed by the incredible transformation that has been accomplished here during the past years. Those of us who have been here before will remember that just a few years ago this was a desolate and distant spot in the great Atacama desert, a place of rare beauty far off the main roads. Now we see in front of us the contours of the world's foremost optical telescope, a project of enormous dimensions and of the greatest complexity. I can think of few other places on the surface of this planet where the purest primordial nature and the most advanced human technology are so intimately intertwined!

I congratulate all of you who have been involved in this great feat. I think on this occasion of the astronomers and the engineers, at ESO and at the participating research institutes, at the numerous industrial firms, in Europe, in Chile and elsewhere, all those legions of dedicated people who have worked hard to design and build the VLT, to install the new observatory at this site, in short, to make a dream come true. Without your persistence and, not least, without your ability to convince the governing bodies that you were right, the VLT would never have happened.

You can imagine how elated we, the representatives of these governments and the members of these committees, feel today. I am sure that I speak for many others when I reveal to you that once the green light was given to the VLT in 1987, there were always small questions in our minds. Yes, this is a wonderful project, yes, it will produce marvellous science, yes, it will stimulate research in Europe and in Chile. Yes, they are all clever and we know that they work hard, but will they manage at the end to keep this complex project, the largest and most expensive of its kind within schedule and, not least, within the budget?

We now know that you managed and that you did so exceedingly well. There are plenty of demonstrations of this. Just think of all of what was shown to us today during the visit to the various areas of this unique site. Think of the deep impression the first results from the VLT have left at all levels, all over the world. Remember the fantastic perspectives for great research projects that were discussed in Antofagasta during the past days.

We are now just a few weeks from the official opening of the Scientific Programmes of the first of the four giant telescopes for the astronomers. The scientists with whom I have talked and who obtained time during the first six-month period are now approaching a mild state of ecstasy – no wonder when you look at what has already been obtained with that instrument during the commissioning phase. Not being an astronomer, I may even find more pleasure in the beautiful photos that have appeared than in the detailed astronomical results you have arrived at. But I have been long enough with the members of this community to sense that something great is coming!

Looking back to the early days of ESO, this international organisation has certainly come a long way: From the signing of the original convention nearly four decades ago, via the agreement two years later between ESO and its host country, the Republic of Chile, to the inauguration in 1969 of the La Silla Observatory and to the decision in that historical Council meeting eleven years ago we have all worked forward towards the day when we could officially inaugurate this new observatory. And it goes without saying that ESO Director Generals who are here today have made great personal contributions to this success over the past three decades!

The VLT project would never have come to where we are now without the close and efficient collaboration, not only between the individual ESO Member States but, in particular, with the host country of this organisation, the Republic of Chile. The VLT programme has indeed developed into an international cosmos of some importance, a fine example to follow during the current efforts to bring European nations closer to each other, but also reaching far beyond the borders of that continent.

Mr. President, we are thankful for your personal support and the persistent efforts of your government and many other authorities in Chile to help us to accomplish the construction of the world's largest and best ground-based optical observatory. The skies above your beautiful country are among the clearest in the world, and soon Chilean scientists, together with their European colleagues, will reap the fruits of our joint labours. There is no doubt in my mind that also at this level, the pioneering role of the VLT will be noted all over the world. And I am particularly glad to learn that ESO will feature prominently in the pavilion of the Republic of Chile at next month's Hannover Fair in Germany, one of the most important in Europe and to which your country has been invited this year as the principal foreign nation.

We are witnessing today an act of solidarity among scientists and politicians, linking culture and business, nations and people. With the power of this new facility, we shall see the faintest and most remote objects in the infinite realms beyond current horizons in space and time. Guided by the astronomers of this world, we shall travel into new territories, physical and philosophical, at the limits of our imagination. We may not understand all what those navigators try to tell us and they may have to work hard to explain to us the significance of some of their discoveries. Still, we are all citizens of this Earth and as such we are all participants, each with our special role, in this large endeavour. There may still be a very long way to go before we uncover the deepest truths about the origin and destiny of the universe. But we will now take some substantial steps in that direction with this wonderful new facility at Paranal.

Let us all be proud of that.

Discourse[1] of His Excellency the President of the Republic of Chile, Don Eduardo Frei Ruiz-Tagle

Señoras y señores:

Significado del Observatorio para Chile

Es una gran satisfacción para mí inaugurar lo que será, dentro de breve tiempo, el telescopio más poderoso del mundo, que viene a responder tan claramente a la necesidad esencial del ser humano de explorar y conocer los orígenes y misterios del universo.

Será aquí, en pleno desierto chileno, a cerca de tres mil metros sobre el nivel del mar, donde convergerán científicos de todo el planeta para investigar los grandes temas de la astrofísica, como el origen, la evolución y el futuro del universo; la formación de grandes estructuras, galaxias, estrellas y sus ciclos de vida; y la formación y evolución de los planetas, que nos permitan conocer las condiciones físicas y químicas apropiadas para el desarrollo de la vida.

Históricamente, esta región del norte de Chile nos ha proporcionado nuestra mayor fuente de riqueza que se esconde al interior de la tierra. Los esforzados mineros del cobre siguen hasta hoy contribuyendo al desarrollo del país y abasteciendo al mundo de importantes materias primas.

Ahora, en esta región, no sólo se explorarán sus profundidades, sino también, se observará hacia las alturas, gracias a sus excepcionales condiciones climáticas que permiten contar con un cielo cristalino ideal para las observaciones astronómicas.

Una asociación amplia con Europa

En esta iniciativa concurren varios aspectos que quisiera destacar:

En primer lugar, el gobierno de Chile y la Organización Europea para la Investigación Astronómica en el Hemisferio Austral han mantenido por más de tres décadas, amplias relaciones de cooperación. Al materializarse hoy uno de los proyectos científicos más ambiciosos del presente siglo, estamos ratificando esta permanente vocación de servicio y colaboración.

Esto es una muestra cabal que el camino hacia nuestra asociación con las principales naciones europeas no se restringe a lo financiero o comercial. Implica también otros desafíos y tareas de suma importancia, que dan un sentido de trascendencia al ser humano y a su relación con el mundo.

Incorporación de los científicos chilenos a la observación astronómica

Los científicos chilenos tendrán un especial acceso a este centro de observación astronómica. Esto se constituirá en un significativo aporte para la labor de nuestros investigadores, quienes contarán con la más moderna tecnología para realizar sus estudios, podrán interactuar con sus colegas de las más diversas latitudes, contribuyendo así al progreso científico.

El esfuerzo del gobierno en materia científica

Este proyecto se inserta en el esfuerzo que ha hecho mi Gobierno para promover la ciencia en nuestro país. Como es conocido, hemos aumentado el apoyo a la investigación científica. Hemos creado las Cátedral Presidenciales, confiando en investigadores destacados, los que han sido selccionados por un comité del más alto nivel mundial. Con modestia puedo señalar que esta iniciativa, nacida en este pequeño país, en que sus investigadores han entrado a la casa de los Presidentes de Chile con toda la dignidad de su quehacer, hoy se destaca en la comunidad científica internacional.

Antes del término de mi mandato, este esfuerzo se consolidará y desplegará en un trascendental proyecto que denominamos Iniciativa Científica Milenio, que cuenta con el especial interés y financiamiento del Banco Mundial. Este esfuerzo está diseñado para que en los próximos diez años el país se incorpore con su talento al proceso mundial de desarrollo del conocimiento científico. Chile no puede quedar atrás. Debe innovar en el modo de hacer ciencia, incentivar a la juventud y así dejar su propia huella en la forma que tomará el mundo en el nuevo milenio.

En este lugar, magnífico testimonio de la capacidad del ser humano, quiero decir a todos los chilenos que la Iniciativa Milenio ha despertado un extraordinario interés en los más importantes ámbitos científicos y agencias internacionales. Se la considera como un prototipo de la forma innovadora con que los países en desarrollo pueden incorporarse a una de las más importantes dimensiones de la globalización, como es el descubrimiento científico.

Señoras y señores, deseo felicitar a todos quienes han hecho posible la concreción de esta iniciativa, incluyendo por cierto a los tabajadores, técnicos y profesionales chilenos que participaron en el levantamiento de estas magníficas instalaciones. Me siento orgulloso como chileno que sea esta desértica región

[1]English translation on page 28.

de nuestro país la que entregará a la humanidad la posibilidad de descifrar innumerables misterios que han desafiado al ser humano durante toda su historia.

Los científicos observarán desde el desierto estos cielos azules y estrellados. Los chilenos estamos abriendo nuestros ojos y nuestras mentes; a través del conocimiento, de la educación y de nuestra participación activa en la exploración de las nuevas fronteras. Sigamos pensando en grande, sigamos proyectándonos al tercer milenio, sigamos comprometiéndonos con la reforma de nuestra educación, sigamos optando con decisión por las personas. Esta es la única forma que nos permitirá superar las barreras que nos separan del desarrollo.

Muchas gracias.

The VLT Opening Symposium

J. BERGERON, ESO

The beginning of the VLT era was marked by two major events: the VLT Official Inauguration Ceremony at Paranal on 5 March 1999, preceded by the VLT Opening Symposium on 1–4 March. ESO is indebted to Professor J.A. Music Tomicic, Rector of the Universidad Católica del Norte, for hosting this symposium. Another major event occurred on the night of 4 March: First light was achieved ahead of schedule at Kueyen, the second 8.2-m VLT unit telescope.

The symposium was dedicated to science opportunities with the VLT and has provided a forum to the 201 participants for discussing current and new projects in several rapidly evolving fields. It consisted of Plenary Sessions on “Science in the VLT Era and Beyond” and three parallel workshops on “Clusters of Galaxies at High Redshift”, “Star-Way to the Universe” and “From Extrasolar Planets to Brown Dwarfs”.

Prof. Juan Andrés Music Tomicic, Rector of Universidad Católica del Norte.

The first Plenary Sessions were devoted to a presentation on Science with FORS and ISAAC by the respective instrument PIs. The hand-over of these instruments to the community for general observations with Antu, the first VLT 8.2-m unit telescope, occurred on 1st April 1999. All areas of astronomical research were discussed in the Plenary Sessions, from where we stand in cosmology to the new frontiers in the solar system. The last Plenary Sessions were devoted to Science in the millimetre wavelength with a new giant telescope project in the Atacama desert of Chile, and the synergy between the VLT and the NGST.

Workshop 1 “Clusters of Galaxies at High Redshift” focussed on the different ways and new prospects in finding clusters of galaxies at $z \lesssim 1$, the cosmological constraints derived from the existence of high-redshift clusters, the content and morphology of cluster members and the gravitational effect of distant compact clusters which magnifies our view of the distant universe.

Workshop 2 “Star-Way to the Universe” concentrated on the use of different stellar populations as distance indicators, age indicators and abundance indicators, thus on the resulting constraints on the age of the universe, the star-formation history of various types of galaxies and the role of different stellar populations in the chemical evolution of galaxies.

Workshop 3 “From Extrasolar Planets to Brown Dwarfs” presented the extraordinary progress made in the discovery of sub-stellar mass companions orbiting solar-type stars and the various prospects for extending the search for planets to stars of all types and to planets with smaller masses and a wide range of separations from their parent stars. Several presentations were also devoted to the physical properties of giant planets and brown dwarfs, the low end of the stellar mass function and formation theories.

A summary of the Symposium highlights will be given in a forthcoming issue of *The Messenger*.

The ALMA Project

R. KURZ and P. SHAVER, ESO

1. Introduction

The Atacama Large Millimetre Array (ALMA) is the new name for the merger of the major millimetre array projects – the European Large Southern Array (LSA), the U.S. Millimetre Array (MMA), and possibly the Japanese Large Millimetre and Submillimetre Array (LMSA), into one global project. This will be the largest ground-based astronomy project of the next decade after VLT/VLTI, and, together with the Next Generation Space Telescope (NGST), one of the two major new facilities for world astronomy coming into operation by the end of the next decade.

The exciting science that can be done with a large millimetre/submillimetre array was summarised in an article in *The Messenger* last year (March 1998, p. 26) and the proceedings of a workshop held at ESO in 1995 (Science with Large Millimetre Arrays). It will detect and study the earliest and most distant galaxies – the epoch of the first light in the Universe. It will also look deep into the dust-obscured regions where stars are born to examine the details of star and planet formation. In addition to these two main science drivers, the array will make major contributions to virtually all fields of astronomical research.

ALMA will be comprised of some 64 12-metre, submillimetre-quality antennas, with baselines extending to at least 10 km. Figure 1 shows an artist's concept of a portion of the array in a compact configuration. Its receivers will cover the frequencies from 70 to 950 GHz. The preliminary estimated cost of the project is US$400 million (1997).

ALMA will be located on the high-altitude (5000 m) Zona de Chajnantor, east of the village of San Pedro de Atacama in Chile. This is an exceptional site for (sub)millimetre astronomy, possibly unique in the world (see article on site testing in the December 1998 issue of *The Messenger*, p. 13). The location of the site is indicated in the photographs on the cover and centre pages of this issue of *The Messenger*. Figure 2 illustrates the remarkably flat (for this altitude) topography ideally suited for installation and operation of ALMA.

The developments prior to 1998 were summarised in the March 1998 *Messenger* article. Here the important developments of the past year, along with the present status of the project, are reviewed.

2. Steps Towards a Global Project

The European Collaboration

In September 1998 the framework for the formal European collaboration in this project was drafted. It called for the establishment of a European Co-ordination Committee (ECC) to direct the European effort and a European Negotiating Team (ENT) to enter into negotiations with other prospective partners. This approach was agreed by ESO Council at an extraordinary meeting on 15 September.

The membership of both the ECC and the ENT was intended to reflect the expected ultimate financial contributions to

Figure 1: Artist's conception of ALMA in a compact configuration.

Figure 2: View (towards the north) of the ALMA site on the Zona de Chajnantor. The prominent mountain at centre-left is Cerro Chajnantor, and to the right is Cerro Chascón.

the construction and operation of the array: four members from ESO, and one each from France (which presently intends to participate separately in this project) and the U.K.

On 17 December the MoU establishing the ECC and ENT was signed by the parties that agreed to fund Phase 1 (the initial 3-year design and development phase) of the project: ESO, Centre National de la Recherche Scientifique (CNRS), Max-Planck-Gesellschaft (MPG), the Netherlands' Foundation for Research in Astronomy (NFRA) and Nederlandse Onderzoekschool Voor Astronomie (NOVA), and the United Kingdom Particle Physics and Astronomy Research Council (PPARC). In addition to defining the organisational structure for the project within Europe, this agreement committed support (in kind and cash) equivalent to at least DM 28 million for Phase 1.

At the same meeting a European Project Manager for Phase 1 was appointed (R. Kurz), and a Science Advisory Committee was established (K. Menten, chair). Subsequently a European Project Scientist has also been appointed (S. Guilloteau). With these actions the top-level structure for Phase 1 of the project within Europe is now in place.

A Joint Project with the U.S.

A resolution between ESO (on behalf of the LSA Consortium and the European community) and the U.S. National Radio Astronomy Observatory (NRAO) was signed in June 1997, in which the parties agreed to pursue the possibility of merging the European and U.S. millimetre array projects into one. Considerable work was done on joint scientific and engineering studies, but it was only with the establishment of the European Negotiating Team (ENT) that it was possible to move on to formal discussions of a joint project.

Following three meetings this year between the ENT and the U.S. National Science Foundation (NSF), a Memorandum of Understanding concerning the design and development phase of a joint array (Phase 1) has now been signed. This commits the signatories both to collaborate in Phase 1, and to endeavour to obtain approval and all necessary funding for collaborative participation in a single project for the construction and operation phase (Phase 2).

The basic principle is that of a 50/50 partnership between Europe and the U.S., with joint overall direction. In the construction phase it is expected that there will be a governing board representing all signatories to the agreement, and a small, co-located global project team led by a single Project Director. There will also be a European Project Office leading the European effort and a U.S. Project Office for the U.S. side. In the operations phase the array will be run by an ALMA Observatory established as a legal entity in Chile, controlled and funded equally by Europe and the U.S.

A Three-way Partnership?

Japan has also been working towards a project of this kind, the Large Millimetre and Submillimetre Array (LMSA). It was decided over a year ago that the LMSA would also be located in the Zona de Chajnantor, and so a collaboration of some kind seemed obvious (in fact, all three groups have been collaborating for years on site testing activities).

Late last year the Japanese astronomical community decided that it would be best to fully merge its project with the European and U.S. projects into one global project. As all three projects are comparable in scale, it was natural to consider an equal three-way partnership. In this case the total array may be a US$600-million project consisting of as many as 96 antennas, giving a total collecting area of over 10,000 m^2 – the original target specified by the European astronomical community to satisfy the cosmological objectives.

The first informal three-way meeting between Europe, the U.S. and Japan to discuss the combined project took place in Washington in February, and a joint resolution was signed in March. Japan also participated in the recent meeting at which Europe and the U.S. signed their MoU, and it is understood that this MoU could be expanded to include Japan. It is hoped that a complete three-way MoU can be signed within the coming months.

Developments in Chile

The Chilean government has set aside a large part of the Zona de Chajnantor as a scientific preserve under the stewardship of CONICYT. Under the terms of the March 1999 resolution, a joint approach will be taken to obtain joint use of this land for ALMA. Following initial discussions with ESO acting on behalf of Europe, the U.S., and Japan, Chile has established a negotiating team with representation of all relevant elements of the Chilean government and led by the Foreign Ministry.

3. Phase 1 Activities

Phase 1 is the design and development phase, extending from 1999 through 2001. In concert with NRAO, the objective of Phase 1 is to completely define a joint programme to construct and operate ALMA (Phase 2). This definition will be the basis for a European proposal for Phase 2 to be submitted not later than June 2000. The products of Phase 1 will include:

- the scientific rationale reflected in unambiguous top-level scientific requirements
- the technical approach and preliminary design validated by demonstrated performance on prototype components or subsystems, including prototype antennas provided by the U.S. and Europe
- the management approach for Phase 2 and a precise division of responsibilities for deliverables embodied in executed agreements between the participants
- the schedule and cost-to-completion derived from a detailed project work breakdown structure with commitment by the participants to deliver the elements for which they are responsible for the estimated cost.

This is a joint activity between Europe and the U.S., as the two projects have been united and brought into phase. The total resources available are US$26 million (U.S.) and DM 28 million (Europe). Efforts are being made to assure that the activities on the two sides of the Atlantic are complementary, and are not duplicated except in those areas where overlapping studies are desirable. The major expenditure will be for the construction of two prototype antennas, one in Europe and one in the U.S.

Figure 3: Several participants from the VLT inauguration ceremony visited the Chajnantor site on 7 March 1999. These include the present Director General Riccardo Giacconi, the Director General designate Catherine Cesarsky, State Secretary Dr. Charles Kleiber (Director of the Swiss Science Agency), and several Council members.

The top-level organisation of the European project team is shown in Figure 4. The programme office is made up of the European Project Manager and Project Scientist plus a European Deputy Project Manager, Richard Wade from Rutherford Appleton Laboratory in the U.K. The seven working teams are led and managed by the following:

- Management: Richard Kurz from ESO
- Science & System: Stephane Guilloteau from IRAM
- Antenna: Torben Andersen from Lund Observatory
- Receiver Subsystem: Wolfgang Wild from NOVA/SRON Groningen
- Backend Subsystem: Alain Baudry from Observatoire de Bordeaux
- Software & Control: Michele Peron from ESO
- Site: Lars-Åke Nyman from OSO/SEST

The elements of the NRAO work breakdown structure for MMA that correspond to the various elements of the European organisation and the NRAO Division Heads for these elements are shown below the European organisation.

The Team Managers are responsible for planning, co-ordinating, monitoring and

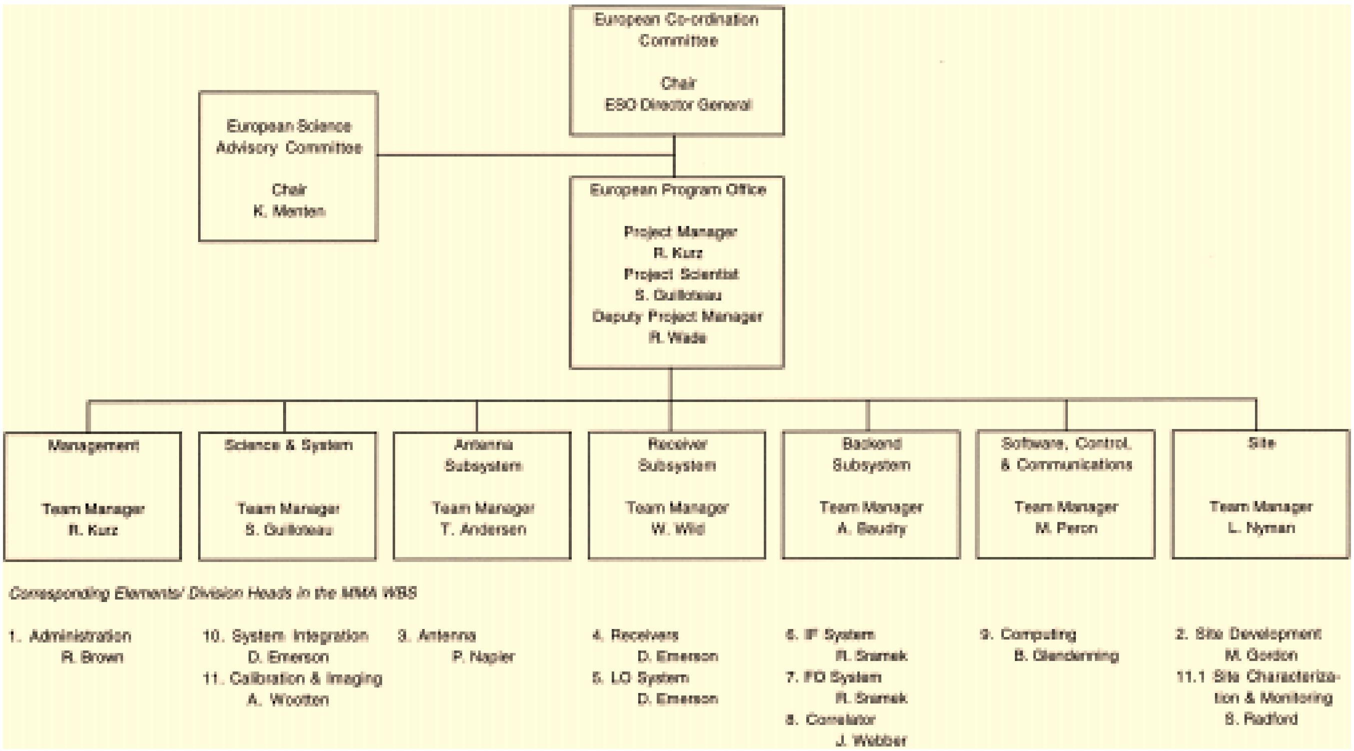


Figure 4: European Phase 1 Organisation.

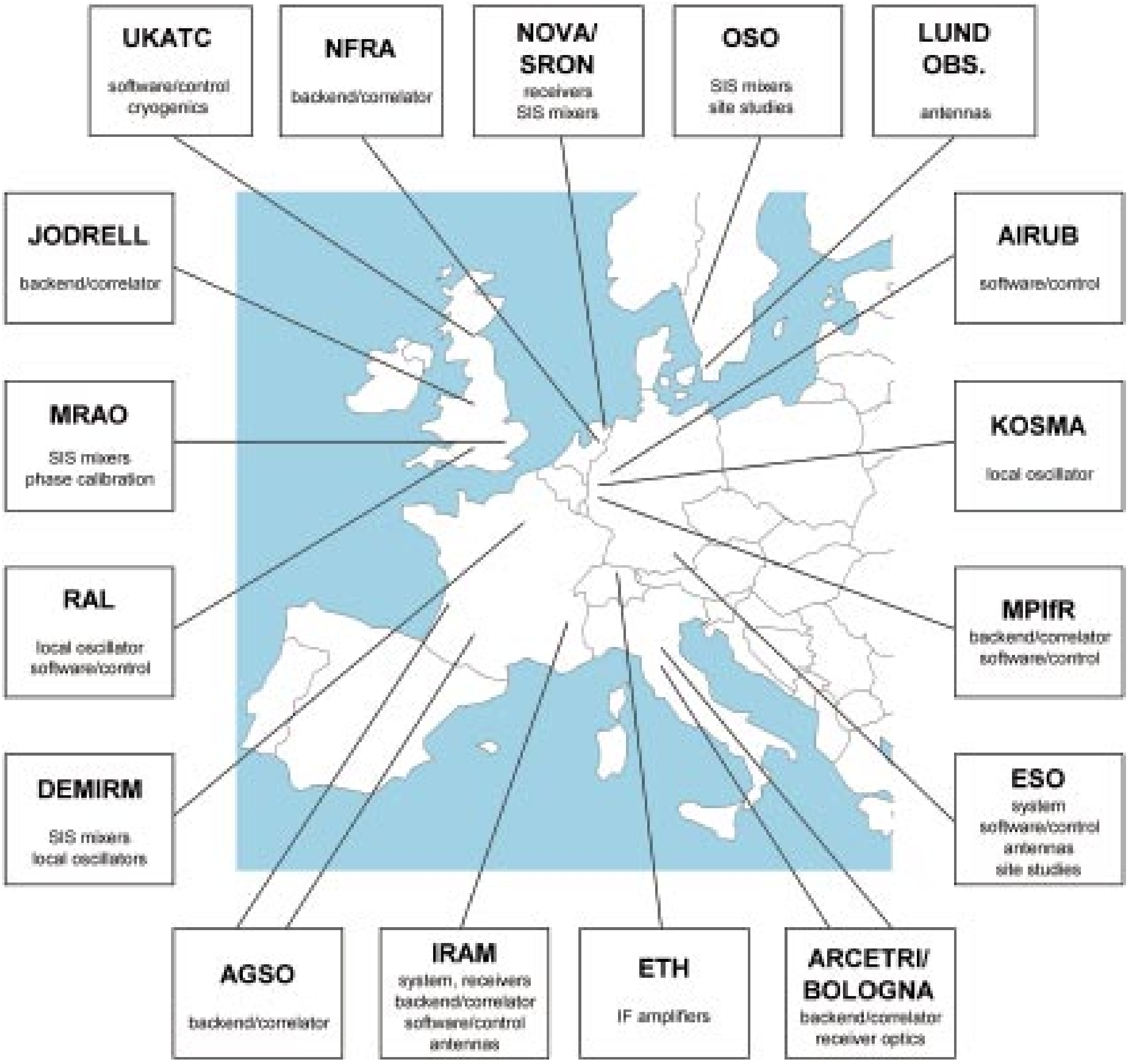


Figure 5: European institutes participating in ALMA.

reporting the work in their area. Figure 5 indicates the diversity of European institutions that are expected to participate in ALMA and their indicated areas of interest. The exact makeup of the seven working teams is still being worked out and the expected activities of the teams are outlined below.

Science and System. Although Europe and the U.S. are in agreement on most of the top-level scientific requirements for ALMA, further definition is required for specific items. A joint science working group will recommend requirements for total power measurement, frequency bands, intermediate frequencies, etc. Early definition of a concept of operations for the full array will be a joint task. This is especially important as a prerequisite to defining the software, control, and communications requirements. A joint array configuration working group will analyse and recommend array configurations taking into account the characteristics and topography of the site. In addition to the joint activities, on the European side we will analyse, prototype, and evaluate radiometric phase calibration techniques using the 183 GHz water line. On its side, the U.S. will investigate total power mode techniques and radiometric phase calibration using the 22 GHz line.

Antennas. The European antenna team will be centred at Lund Observatory with support from ESO and IRAM. Effort in the antenna area is focussed on the design, construction, assembly, and testing of prototype antennas by both the U.S. and Europe. The U.S. has taken the lead in compiling the specifications for the prototype antenna. In the last several months this effort has become a fully joint effort. Each side will procure a prototype antenna satisfying the common technical requirements. These procurements will be closely co-ordinated. The European contract will be technically monitored by the antenna team and administered by ESO's Contracts and Procurement organisation. We will jointly evaluate and test these antennas, individually and as a single-baseline interferometer. Finally, both sides will investigate metrology techniques for possible evaluation on the prototype antennas.

Receivers. The receiver area will have participation from a large number of institutes in Europe, as indicated in Figure 5. There will be a single joint European/U.S. design of the receivers at the subsystem level. A wide range of component development activities are proposed on the U.S. and European sides – SIS junctions and mixers at different frequencies, photonic and conventional local oscillators, and a multi-channel cryostat. A near-term aim of the planning in this area will be to reduce duplication and overlap in the developments. Both sides will do production planning and cost estimation for the full array receivers and NRAO plans to build and test a prototype receiver. NRAO will also design and produce the receivers to be used in evaluating both prototype antennas (these are not prototype receivers for the full array).

Backend Electronics. As in other subsystems, a joint backend design will be developed at the subsystem level. Both sides will pursue development and testing of fibre optic signal transmission with emphasis on analogue techniques in the U.S. and digital techniques in Europe. The U.S. will build a correlator based on an existing design to be used in testing the two prototype antennas in a single-baseline interferometer configuration. They will also design and carry out component development for a quarter-size correlator (inputs from up to 32 antennas), again based on existing technology. During Phase 1, Europe will concentrate on de-

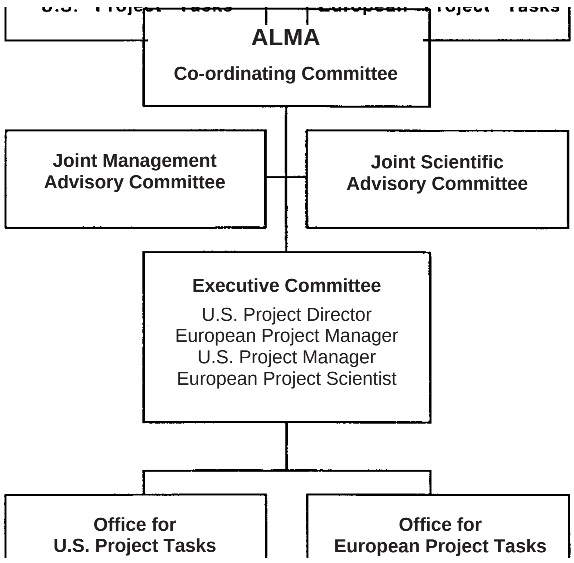


Figure 6: Joint U.S./European Phase 1 Management Structure.

signing an advanced (second-generation) correlator that would exploit the latest in microelectronics capability. The decision to proceed with either a scaled-up U.S. design or the European advanced correlator will be made early in Phase 2.

Software, Controls, and Communications. Joint definition of the software, controls, and communications requirements based on the concept of operations generated by the Science & System team will be the first task. Following this, a joint top-level software, controls, and communications subsystem design plus joint definition of the software development environment will be performed. ESO will lead the effort on software engineering to define the standards and processes to implement the software and control subsystems. Once this framework and the overall subsystem is specified and designed, responsibility for development of the various subsystems will be distributed amongst the participating institutions. In Phase 1 this will include development of the first increment of common software in Europe. The U.S. will take the lead in development of the sofware needed for evaluation and testing of the prototype antennas, both singly and as an interferometer.

Site. Europe, the U.S. and Japan have all been collaborating on site testing in Chile for several years, and there is now complete agreement on the Chajnantor site. The equipment from all groups is now located there and co-ordinated in a common test campaign. Europe is responsible for operation and first-line maintenance of the characterisation equipment at Chajnantor. Analysis and interpretation of the site characterisation data is a joint task. Negotiations with Chile to gain the necessary rights of access to the site will be conducted jointly. Geotechnical and environmental studies will also be part of Phase 1, with Europe administering the study contracts. NRAO has already done a significant amount of site development planning and produced a first comprehensive cost estimate. This will continue as a joint activity, leading to the bid packages that are expected to be one of the first major contracting activities of Phase 2.

Management. Overall Phase 1 management and co-ordination will be a joint activity (see Figure 6) with each side managing their respective project tasks. The major task in the management area, in addition to managing the Phase 1 work, will be the complete programmatic definition of Phase 2, including the management structure, the detailed definition and division of work between the U.S. and Europe, and estimation of the cost to complete the full array. We will work with NRAO to build a complete parametric cost model in accordance with the work breakdown structure. This model will be built in parallel with the scientific end-to-end performance model based on the same parameters. Operational analysis to determine the most cost-effective approach to developing the facilities in Chile and to assembling and operating the array will be an essential part of fully defining Phase 2.

4. The Major Milestones Ahead

Phase 1 of this project has moved into high gear, and the timescales are tight. The upcoming major milestones are as follows:

- October 1999: award of the prototype antenna contracts
- November 1999: completion of joint Europe/US management plan
- May 2000: completion of Phase 2 proposal
- December 2000: approval of Phase 2 by ESO Council
- December 2000: signing of international agreement for Phase 2
- July 2001: prototype antenna delivery, system PDR

Phase 2 begins in 2001. A joint array preliminary design review will take place in the middle of that year, and the site development will start. By 2005 there should be sufficient antennas on site for a subarray to begin operation. The complete array should be available by 2009.

More information on the project can be found at the ALMA web site,
http://www.eso.org/projects/alma/

A FIRST FOR THE VLT

OBSERVATIONS OF THE GAMMA RAY BURST GRB990510, AND DISCOVERY OF LINEAR POLARISATION

International teams of astronomers are now busy working on new and exciting data obtained in May with telescopes at the European Southern Observatory (ESO).

Their object of study is the remnant of a mysterious cosmic explosion far out in space, first detected as a gigantic outburst of gamma rays on May 10, GRB990510.

Gamma-Ray Bursters (GRBs) are brief flashes of very energetic radiation – they represent by far the most powerful type of explosion known in the Universe and their afterglow in optical light can be 10 million times brighter than the brightest supernovae. The May 10 event ranks among the brightest one hundred of the over 2500 GRBs detected in the last decade.

The new observations include detailed images and spectra from the VLT 8.2-m ANTU (UT1) telescope at Paranal, obtained at short notice during a special Target of Opportunity programme. This happened just over one month after that telescope entered into regular service and demonstrates its great potential for exciting science.

In particular, in an observational first, the VLT measured linear polarisation of the light from the optical counterpart, confirming that synchrotron radiation is involved. It also determined the redshift of the host galaxy of GRB990510, $z = 1.619$, corresponding to a distance of more than 7,000 million light-years to this GRB (assuming a Hubble Constant $H_0 = 70$ kms^{-1} Mpc^{-1}, a mean density $Omega_0 = 0.3$ and a Cosmological Constant Lambda = 0).

This is an excerpt of the ESO press release of 18 May 1999 where more information on the science and organisation of this collaboration can be found including the name of the astronomers who participated in this investigation and the web site address of their institutes.

The full text and 7 pictures are at: www.eso.org/outreach/press-rel/pr-1999/pr-08-99.html

FORS1 and ISAAC Science Verification at Antu/UT1

A. RENZINI, ESO

The UT1/Antu Science Verification (SV) programme with the Test Camera, which was carried out in August 1998, included one major project (the multi-colour coverage of the HDF-S) plus a number of short programmes meant to address problems in a wide range of astrophysical areas. For the SV of the two instruments now attached to UT1/Antu (FORS1 and ISAAC) the same approach was followed, giving high priority to those programmes that potentially serve a wide section of the community. The aim of this strategy was to maximise the probability success and the scientific return, while providing the best possible service to the community and pushing to the limit the capabilities of telescope and instruments. The many goals of the SV of the VLT and its instruments are extensively discussed elsewhere (Giacconi et al. 1999, *A&A*, 343, L1, and references therein).

The scientific programmes were selected according to the following selection criteria:

- outstanding scientific interest
- very challenging for VLT+Instrument capabilities
- sufficiently complete datasets to allow prompt scientific exploitation
- requiring most frequently used instrument modes
- existence of many potential users within the ESO Community
- complementarity with other available datasets (e.g. HST).

SV observations were planned to be executed on January 14–21 for FORS1 and on February 18–25 for ISAAC. However, this schedule could not be met due to a combination of meteorological and technical reasons, which delayed the Commissioning of the two instruments. In order to deliver to the ESO users the UT1/Antu telescope in due time (April 1, 1999), only part of the SV plans could actually be completed.

Nevertheless, part of the FORS1 SV observations were successfully executed during January 1999 by the VLT Commissioning Team, and transferred to the SV Team for the data reduction and preparation for public delivery. These SV data were part of the ESO Press Release of February 27, and were presented to the VLT Opening Symposium in Antofagasta on March 1.

For SV observations with the ISAAC instrument the SV Team could acquire data only during part of the night of February 28. These data have been later supplemented by additional observations of SV targets carried out in March by the ISAAC Commissioning Team. The Commissioning Teams having executed the January and March observations included: F. Comerón, J.-G. Cuby, R. Gilmozzi, C. Lidman, G. Rupprecht, J. Spyromilio.

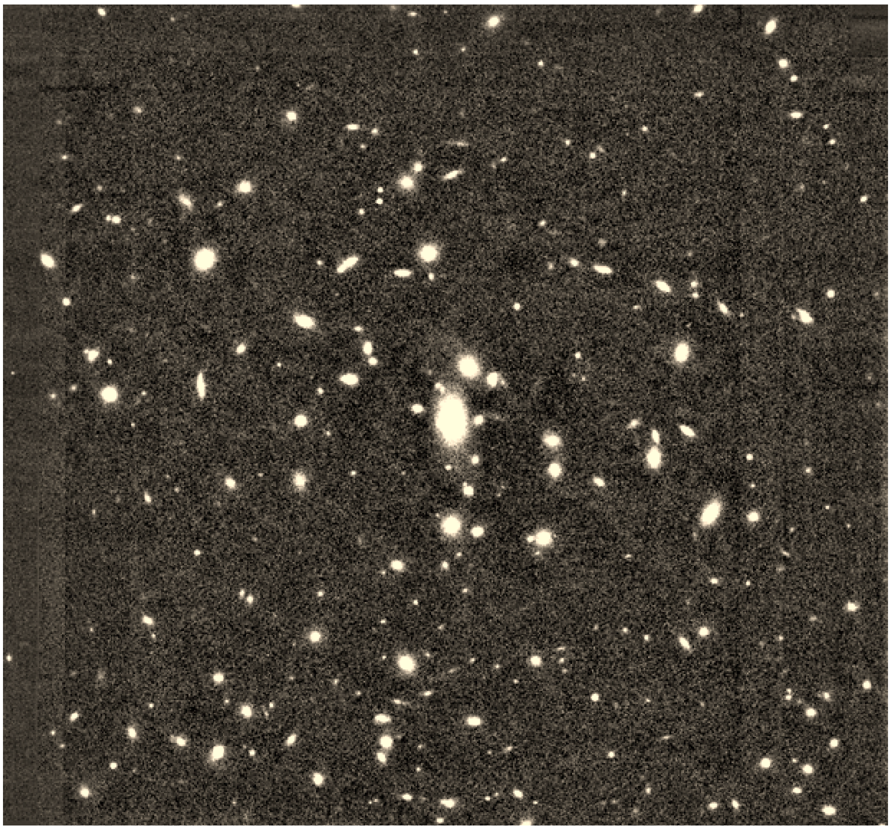


Figure 1: ISAAC K_s image of the cluster MS1008-12. Total exposure is 60 minutes; seeing ~ 0.45″; field 2.5′ × 2.5′.

All the SV data have been reduced and calibrated by the SV Team, and prepared for public release.

Although not as deep, complete and optimally calibrated as originally envisaged, these SV data still demonstrate the enormous scientific potential of the VLT and its first instruments. These are science grade data that all astronomers in the ESO community can now scientifically exploit, thus having an early access to FORS1 and ISAAC data.

The FORS1/ISAAC SV Team includes the following scientists: J. Alves, S. Cristiani, R. Hook, R. Ibata, M. Kissler-Patig, P. Møller, M. Nonino, B. Pirenne, R. Rengelink, A, Renzini, P. Rosati, D. Silva, E. Tolstoy, and A. Wicenec.

The SV Team took responsibility for the selection of the targets, the data reduction and quality evaluation. The team also ensured that the results were promptly disseminated and eventually fully exploited by promoting the involvement of scientists from the community. The SV Team remains the prime contact for the astronomers interested in using the SV data, will assist them as required, and will be responsible for collecting feedback from them.

Both FORS and ISAAC are imaging spectrographs, and a major imaging as well as a major spectroscopic programme were planned for them. For FORS1 a multiobject spectroscopy (MOS) programme was designed since this is the most challenging technique.

For the imaging programme the aim has been to obtain very deep, multicolour images in optical and near-IR bands of a moderate redshift galaxy cluster (Fig. 1).

For the FORS1 MOS programme the SV observations concentrated on Lyman-break galaxies. Targets were selected from databases that are accessible to ESO users, with emphasis on existing publicly available data such as the EIS Deep Fields. Therefore, SV focused on targets in the so-called AXAF field. Moreover, during the second Commissioning phase of FORS1 in December 1998, the FORS1 Commissioning Team led by I. Appenzeller collected MOS observations of candidate Lyman-break galaxies in the Hubble Deep Field South (HDF-S), drawn from the EIS-Deep Survey. The data have been reduced by the SV Team, and they are now part of the present release (e.g. Fig. 2).

The SV Team acknowledges the effort made by the EIS Team for the prompt release of the survey products that made possible spectroscopic follow-up observations in a timely fashion.

The SV Team also prepared a broad range of small programmes and backup programmes to be executed in case the weather conditions would not meet the requirements of the main programmes (e.g. poor seeing, high cirrus, etc.). Most of these projects could not be executed, for the reasons mentioned above. However, science grade data were obtained for the following programmes:

• FORS1 Broad-band imaging of Antlia, the dwarf irregular galaxy recently discovered in the Local Group.

• ISAAC Spectroscopy of the Highly-magnified Galaxy MS1512–cB58 at z = 2.72.

The FORS1/ISAAC SV data were released through the ESO web site on May 10, 1999 and are accessible at http://http.hq.eso.org/science/sv/

Few more data taken by the Commissioning Team are yet to be fully reduced and evaluated, and will be released as soon as possible.

arenzini@eso.org

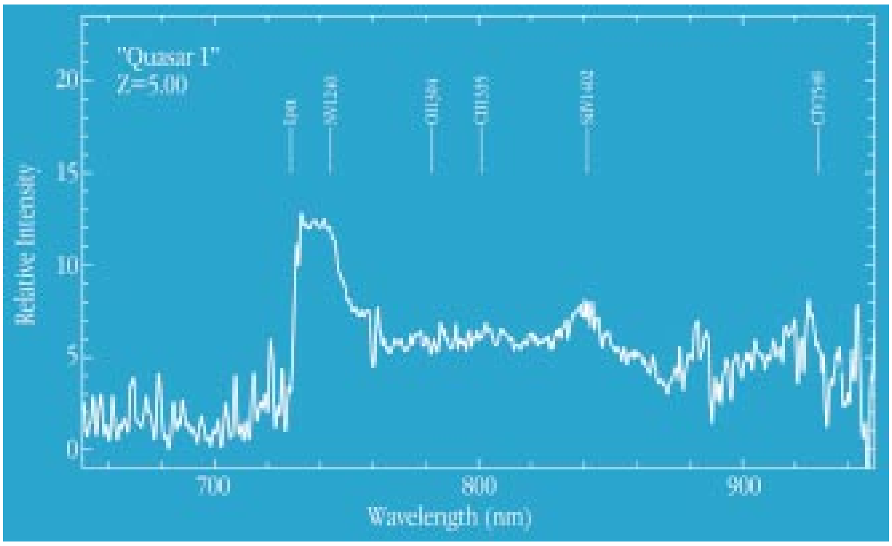


Figure 2: FORS1 Spectrum of "Quasar 1", discovered by X. Fan et al. within the Sloan Digital Sky Survey Collaboration. The redshift is no less than 5.0.

UT2/Kueyen: a Stellar Astronomer's Dream Comes True

A. RENZINI, ESO

Stellar astrophysics is today a mature science. Many of the fundamental questions have received reasonably satisfactory answers, leaving more subtle, harder and harder problems yet to be solved. A typical example of success is offered by the quantitative knowledge of stellar evolution. We have now a fairly complete understanding on how stars of all masses evolve, from the main sequence all the way to the white dwarf stage or supernova explosion. Perhaps it is not too exaggerated to say that just details remain here and there to be worked out. On the other hand, an example of a hard, still unsolved problem is star formation. Many beautiful images of star-forming regions have been obtained, and still the physics of star formation defies our understanding: predicting from first principles the initial mass function and the star-formation rate has so far proved to be beyond our grasp. Star formation is indeed a very complex physical process, dominated by hydrodynamical/magnetohydrodynamical phenomena that can hardly be formulated by simple algorithms, and that even the biggest computers cannot properly handle. Hence, progress in this field has been slow, and is likely to remain slow for a while. In general, still poorly understood are all those phenomena in which hydrodynamics (especially if chaotic) plays a prominent role, such as convection, mixing, mass loss, common envelope phases, etc. It is important to realise that most often the limit to our understanding does not come from insufficient observations, but rather from the intrinsic complexity of the involved physical processes (not unlike the case of many problems in solar physics). This is to say that even the VLT will not accelerate much the progress in some areas of stellar astronomy. Therefore, while the VLT is entering its fully operational life, it is worth addressing the question of its role vis-à-vis stellar astronomy.

As is well known, the ESO astronomical community has a very strong tradition in stellar astrophysics, with a majority of astronomers in virtually all member states being dedicated to stellar studies. Yet, for the first VLT Observing Period (P63), only 19% of the requested (and allocated) time was for stellar proposals. About 72% of the time was requested for extragalactic astronomy proposals, and the rest was shared by Interstellar Medium and Solar System projects. Nearly the same proportions are also maintained in P64. Does this signal a low interest of the stellar community towards the VLT? At a time when observational cosmology is experiencing its most rapid progress, and a brand new branch of astronomy – exoplanets – is exploding, what space is left to stellar astronomy?

The minority role played by stellar astronomy in P63 and P64 should not be over-interpreted. Indeed, the instrumentation offered at UT1/Antu for these two periods was very attractive for extragalactic studies, but FORS1 and ISAAC could satisfy the needs of only a fraction of the stellar community. By good fortune, UT1/Antu is just the first telescope of the VLT quartet, and the situation is likely to change dramatically already with UT2/Kueyen, which is now being commissioned. Indeed, with this second VLT unit the dreams of many stellar astronomers are about to come true.

UT2/Kueyen will be a spectacular, unique machine for high spectral resolution studies. Figure 1 shows the instrumental complement of this telescope. The Cassegrain focus will feed FORS2, capable of a resolution ($R = \lambda/\Delta\lambda$) up to ~ 4000, and multiplex up to ~ 100.

The high-resolution echelle spectrograph – UVES – will occupy one of the two Nasmyth platforms, and will reach $R \simeq$ 120,000. Both these instruments will be offered to the users in P65, starting April 1, 2000, and the deadline for the submission of proposals is October 1, 1999. Finally, at the other Nasmyth platform the fibre positioner (OzPoz) will be installed in the summer of 2001, along with the medium-high-resolution spectrograph GIRAFFE.

With the installation of OzPoz and GIRAFFE, the high multiplex machine called FLAMES will take shape. FLAMES is OzPoz+GIRAFFE+UVES, plus the software to orchestrate them. In the MEDUSA mode, OzPoz will send 132 fibres to GIRAFFE, capable of getting the spectra of as many objects with R = 7000 or R = 15,000. OzPoz could also dispatch 8 fibres to the other Nasmyth platform, and feed UVES promoting this spectrograph to high multiplex at $R \simeq 40{,}000$. It will also be possible to use GIRAFFE and UVES simultaneously, observing the eight brightest objects in a given programme with UVES at higher resolution, while gathering lower-resolution spectra of over 100 fainter objects with GIRAFFE. More extensive information on UT2/Kueyen instrumentation can be accessed on http://http.hq.eso.org/instruments/.

While it is easy to imagine several extragalactic applications for each of these

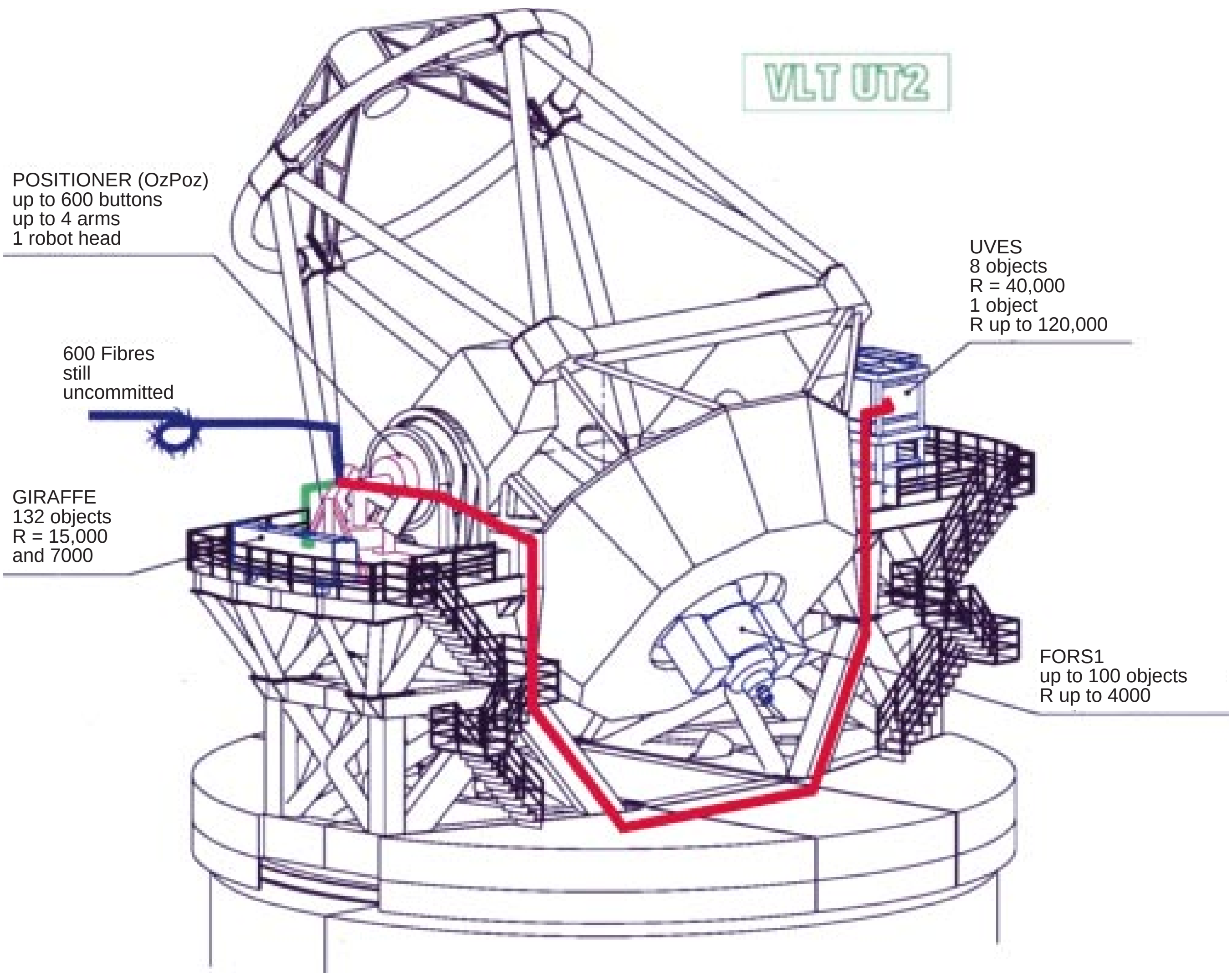


Figure 1: A schematic view of the instrumentation attached to UT2/Kueyen. The fibre Positioner (OzPoz) can feed either the medium/high-resolution spectrograph GIRAFFE, or UVES, or both at the same time. For each instrument the spectral resolution and multiplex are indicated. With minor upgrade, the Positioner could locate on the focal plate up to 600 fibre buttons, a multiplex capability that still remains to be exploited.

instruments, it is stellar astronomy which is likely to make use of the great advantage of such an instrumental complement. This is especially the case of stellar population studies, since within few years it will be possible to obtain high-resolution spectra for thousands and thousands of stars in, e.g., the Galactic bulge, open and globular clusters, the Magellanic Clouds, and the dwarf spheroidal galaxies, thus obtaining unique, extensive information on the detailed chemical abundances and kinematics of so many stars.

The determination of the elemental abundances of iron, the α-elements, as well as the s- and r-process elements, will allow us to gather a very detailed picture of the chemical evolution of the Galactic spheroid and disk, as well as of the dwarf satellites of the Galaxy, thus shedding fresh light on the formation and evolution of the Milky Way galaxy. The abundance of cosmologically interesting elements such as lithium could be determined for thousands of stars in just one observing run, along with other relevant information such as rotational velocity, chromospheric activity, etc. In its integral field unit mode (ARGUS) GIRAFFE could take high-resolution spectra of all objects in a very crowded field, such as the central regions of globular clusters, thus helping identifying the optical counterparts of low-mass X-ray binaries, or studying the dynamics of collapsed cores. Of course, these are just some of the major stellar population studies that will become possible with FLAMES, many others will certainly be invented by the creativity of the users.

Accurate co-ordinates for the programme stars will be necessary in order to precisely position the fibres when FLAMES will be used in the MEDUSA mode, or to feed UVES. FLAMES does not have an imager of its own, and therefore astrometry will have to be obtained from images taken at other telescopes. The Wide Field Imager at the 2.2-m telescope (WFI@2.2) will be ideal for this purpose. With its $34' \times 33'$ field of view it will perfectly match the OzPoz field of view (25′ diameter). It is expected that the most efficient use of FLAMES will need ~ 400 stellar fields per year with high astrometric accuracy. About half of them are expected to be provided by individual preparatory programmes, addressing very specific scientific goals and producing their own target lists. However, one expects that a major fraction of the projects will concentrate on a relatively small number of fields. The Working Group for Public Surveys in its meeting of March 22–23, 1999, has recommended ESO to take shallow (8-min) *UVI* exposures with WFI@2.2 for ~ 200 among the most obvious fields in the Galactic bulge, LMC and SMC, as well as in dwarf spheroidals, open clusters, and nearby globular clusters. The corresponding proposal for such a public survey to be conducted over the next four observing periods has been submitted to the OPC in response to the P64 call for proposals. Other widely used fields could be added in the future in response to requests from the community of the users. In this way, the survey will provide public backbone data, while users with very specific interests could apply for obtaining complementary data.

Though others may have a different taste, I dare to say that the identification of the progenitors of Type Ia supernovae is the single most important unsolved problem in stellar astrophysics (perhaps second only to the origin of gamma-ray bursters). Suffice to think of the role of Type Ia supernovae in the chemical evolution of galaxies and clusters of galaxies, or in providing a tool to measure the variation with cosmological time in the rate of universal expansion. For over 15 years two scenarios have been considered without being able to decide among them. In common to both is the basic mechanism: the thermonuclear explosion of a white dwarf (WD) accreting material until a critical mass is reached. But the two options diverge on the nature of the mass donor: a giant star filling its Roche lobe in the single degenerate (SD) scenario, another WD spiralling in due to gravitational wave radiation in the double degenerate (DD) scenario. Searches for DD systems have been only partly successful, being painfully slow at 4-m-class telescopes. The VLT now offers a chance to thoroughly address this problem, by checking a great number of WDs for radial velocity changes due to orbital motion. Unfortunately, the surface density of WDs is too low for exploiting the high multiplex of FLAMES (just 2 or 3 per square degree down to magnitude 20). However, WDs are all over the sky, and a snapshot survey with UVES will be ideal for filling in gaps in the night schedule when UT2/Kueyen will be used in Service Mode. At the high resolution of UVES, DD systems could be easily identified with just two short exposure spectra, with further observations allowing to determine the period. In five years, with a few minutes per WD, of order of 1000 WDs could be checked for binarity by investing just a few percent of the fraction of the UVES time that will be operated in service mode. Besides possibly finding a number of SNIa precursors, such a survey would provide unique information on the endpoints of interacting binary-star evolution, as well as a unique database of WD spectra.

Some among the stellar astronomers may have had the perception of the access to VLT data being overwhelmingly difficult. Actually, quite the opposite is going to be true: the flow of stellar data from the VLT is likely to be so high that a major fraction may not be promptly processed and exploited for shortage of astronomers who can do it. For example, it is estimated that with FLAMES absorbing some 80 nights/year for stellar studies, about 400,000 high-resolution spectra will be obtained during the first five years of operation[1]. Like all VLT data, all these spectra will become publicly available one year after the observations, allowing others than the proposing group of astronomers to refine (or even anticipate!) the scientific analysis. This will be especially interesting in the case of stellar high-spectral-resolution studies, in which the scientific result is at least as dependent on the actual modelling as it is on the quality of the original data. Rather than being a threat for stellar astronomers, the VLT offers to this component of the ESO community a great deal of opportunities. Deadline for applications for Period 65 is October 1, 1999.

[1] For comparison, note that high-resolution spectra are presently available for just a dozen stars in the Galactic bulge.

arenzini@eso.org

VLT Instrumentation Renewal

G. MONNET, ESO

I. The Rationale

At the time of this writing, ESO, with a major contribution from its community, is embarked on the so-called first-generation VLT instrumentation plan, with eleven different instruments for as many foci of the VLT, plus four instruments for the VLTI. The first two instruments (ISAAC and FORS1) have just been put in operation, with two others (UVES and FORS2) planned to join them in about 9 months. Succeeding in this ambitious endeavour is our present first and utmost priority.

When this major effort is completed around 2003–2004, we will then be faced with the prospect of almost immediately restarting new instrumentation, as the first instruments installed will be well in the midst of their likely 10–12 years useful life.

Peering just a little bit into a crystal ball, one can see indeed at least three different rationales which will likely push towards a substantial renewal of the presently planned first instrumentation complement of the VLT, namely:

• shifts in emphasis between major astronomical fields to be addressed with the VLT, as well as within these fields,

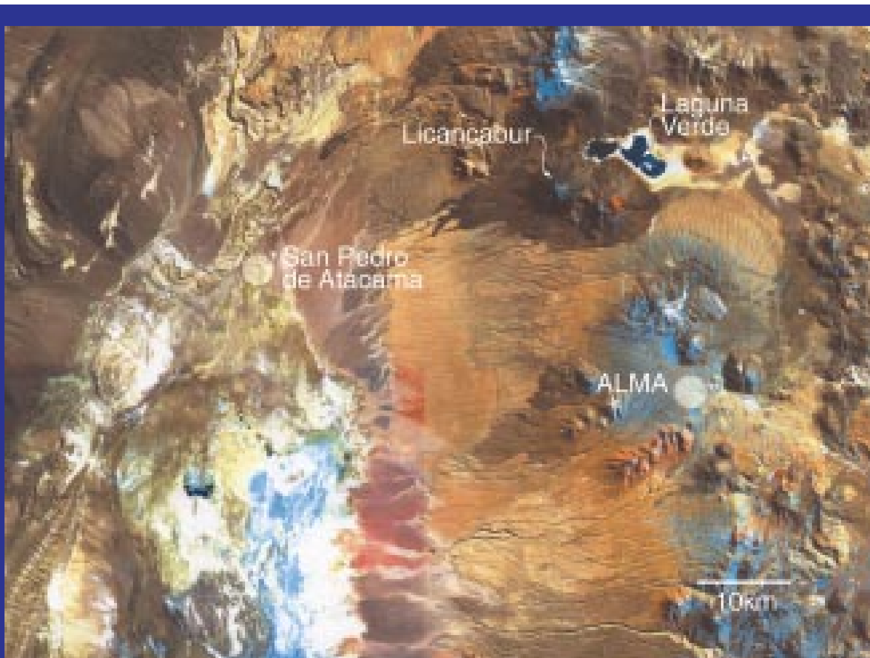
(Continued on page 18)

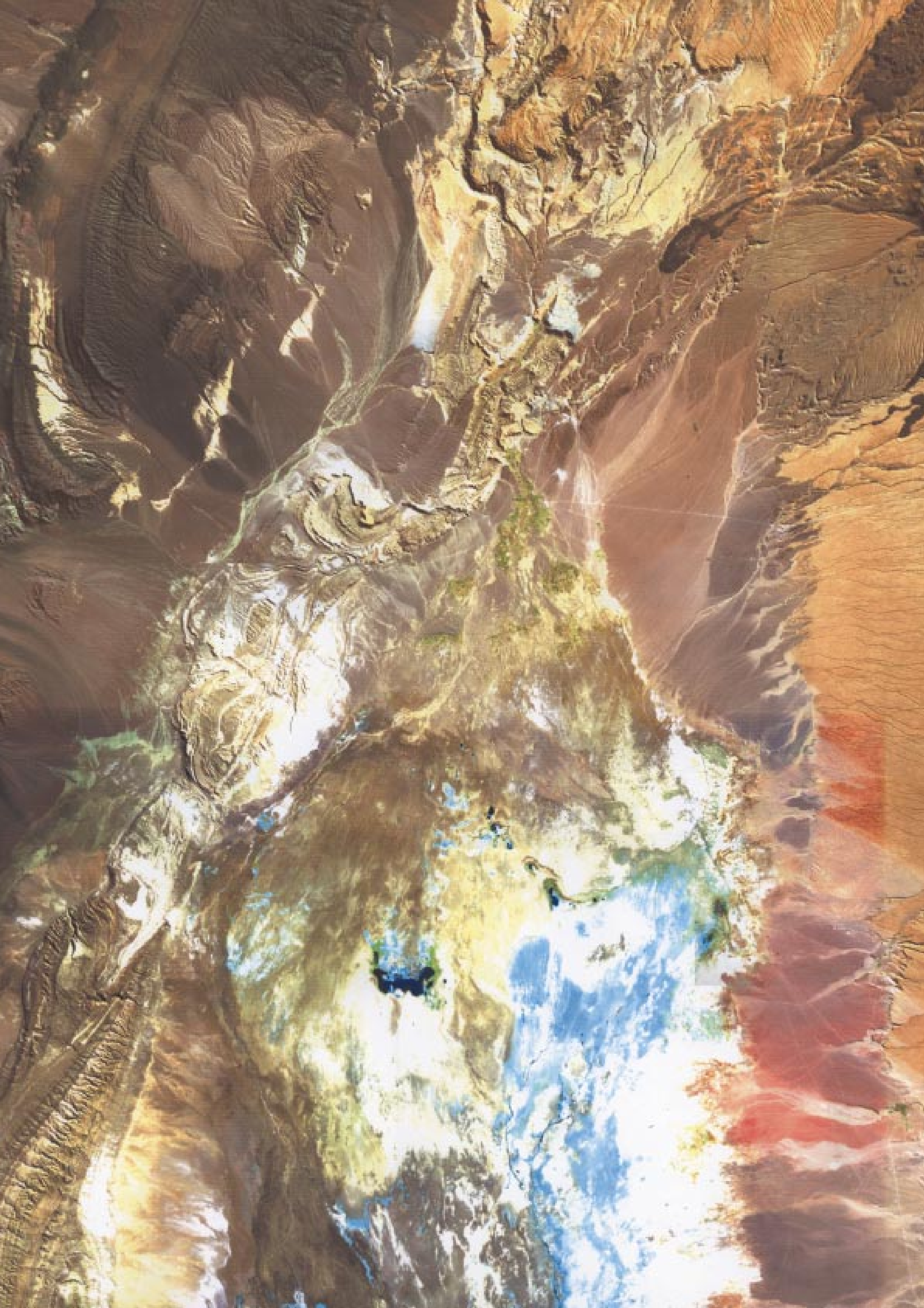
Centrefold

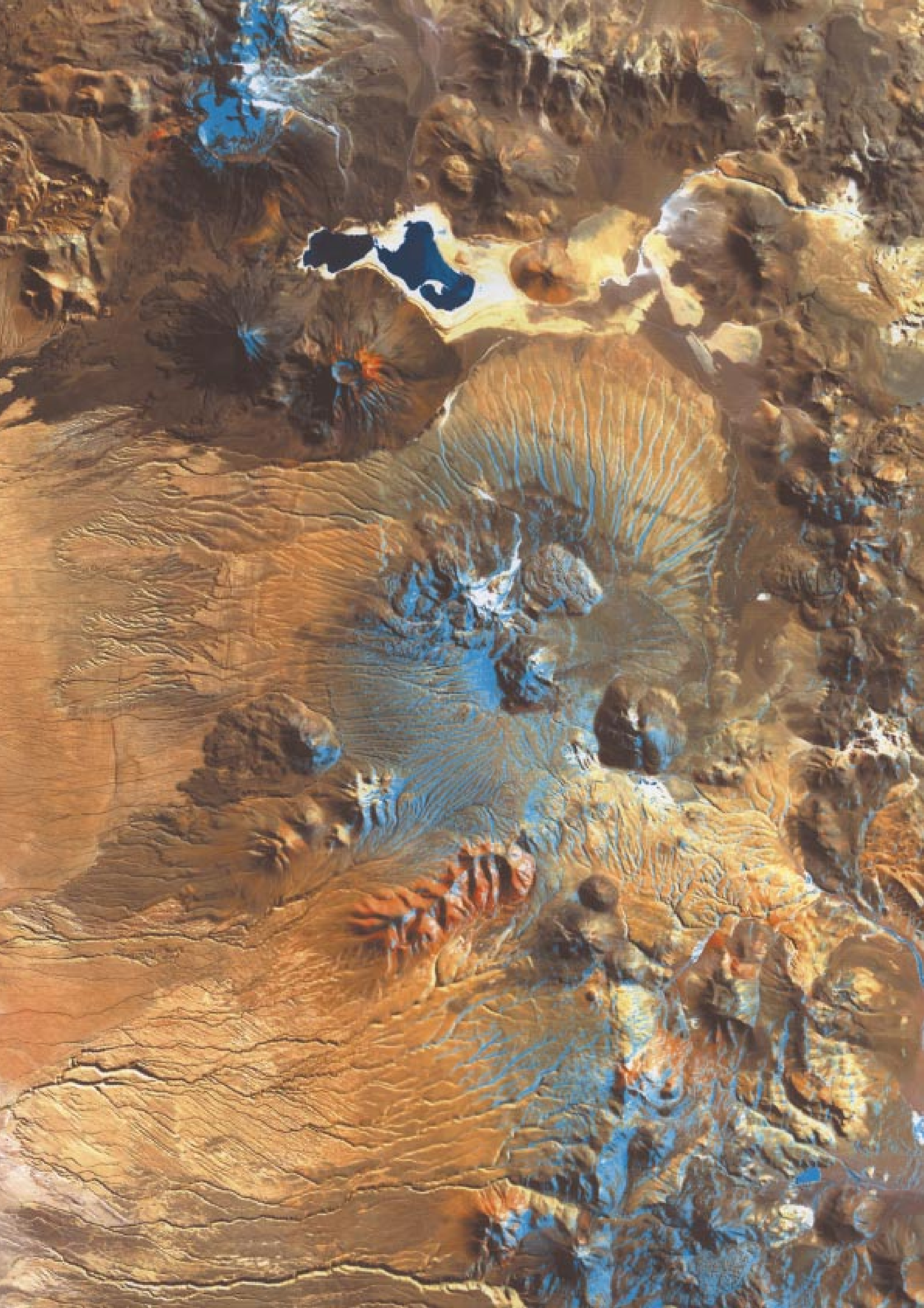
Satellite image showing the proposed location of ALMA, the Atacama Large Millimetre Array (see article on page 7 in this issue of The Messenger). Also indicated are the town of San Pedro de Atacama, the prominent volcano Licancabour, and the Laguna Verde.

This image is a composite of three exposures in spectral bands at 1.6 μm (rendered red), 1.0 μm (green) and 0.5 μm (blue). The horizontal resolution of the false-colour image is about 30 metres. North is at the top of the photo.

The image was produced in 1998 at Cornell University (USA), by Jennifer Yu, Jeremy Darling and Riccardo Giovanelli, using the Thematic Mapper data base maintained at the Geology Department laboratory directed by Bryan Isacks, and is reproduced here with their kind permission.







(Continued from page15)

• a seismic change in the level of competition in the 8-m-class club with the advent of the NGST in 2007+, given its huge natural edge, especially beyond $\lambda \sim 2.2$ µm,

• steady advances in the relevant technological fields, some leading to upgrades of existing instruments (e.g. lower-noise detectors), but others requiring brand new instrumentation to fulfil their potential (e.g. high-order adaptive optics at visible wavelengths).

II. The VLT and Observational Cosmology

Observational Cosmology is widely perceived as the key scientific field for 8-m-class telescopes, at least for the next decade, with the goal of unravelling geometric (the underlying structure of the Universe) and evolution (galaxy formation) effects.

For the determination of the structural parameters of the Universe (H_0, q_0, Λ, …), much hope resides in post-COBE microwave background fluctuations determinations from dedicated satellites, but two alternative ground-based avenues still warrant being pursued, namely wide-field weak gravitational shearing and the use of SNIa's as standard candles. VIMOS will be our main tool for deriving weak shearing and must also provide an effective, if time consuming, way to detect high z (> 1) supernovae. For weak shearing, the main difficulty will be to get a highly stable spatial point-spread function over the large $14' \times 14'$ field of the instrument. It is presently quite uncertain how well that can be achieved at the VLT with its actively controlled M1/M2 mirrors. This important issue will be thoroughly checked during VIMOS commissioning in mid-2000.

Present emphasis in evolution studies lies in studying the early history of (massive) Star Formation. This is done either directly from the measure of the stars near-UV continuum or indirectly, using optical emission lines, e.g. the Hα recombination line, as a probe of their far-UV fluxes. A major by-product of these studies is a quantitative determination of the early chemical evolution in the Universe. In the next years, this is quite likely to move to the even most difficult task of determining the early history of mass assembly in the Universe, in the $z = 1$ to 5 redshift range. This new domain will, of course, be one of the main hunting grounds of the NGST. Nevertheless, much would still be addressable from the ground, with an adaptive optics enhanced ($0''.1$–$0''.2$ angular resolution), 0.6 to 2.2 µm wavelength range, $\Re \sim 3{,}000$ spectral resolution, integral field spectrographic capability. Such an instrument would permit the measurement of the mass distribution of faint galaxies up to $z = 4$, both from ionised gas ([OII] 3727Å) and from stellar light dynamics (CaII 3980–4227Å), and would be quite competitive in that redshift range w.r.t. NGST.

In addition, fishing for the first points of light ($z \gg 5$) in the Universe is too glamorous to be ignored. This, ultimately, will be the forte of NGST, but meanwhile will be pursued from the ground in a variety of ways: detection of rare high z quasars with ΩCAM at the VLT Survey Telescope; detection of I, Z or perhaps even J dropouts[1] with VIMOS and NIRMOS. We are on the other hand currently lacking one niche capability, viz. a tuneable filter to search for faint emission around high z objects (clustering around QSOs of known redshift, cluster member emission lines galaxies, etc.). Possibly, this capability could be inserted in a present VLT instrument, e.g. FORS1. In that application, however, very long integration times on single fields (> 100 hrs) are usually required, which may point to using e.g. the NTT at the La Silla Observatory instead of a VLT Unit Telescope.

III. The VLT and Large Scale Structure

We are investing heavily in this field, with VIMOS and NIRMOS for the study of the large-scale distribution of baryons, in the form of individual galaxies. In addition, UVES, with its eight simultaneous objects high spectral resolution capability in a half a degree field, should become a significant player in the study of dark matter large-scale distribution from the Lyα forest in front of high-z quasars.

One way to increase even more our capabilities in that domain would be to use the full 600 fibres potential capacity in a 27′ diameter field of FLAMES on Kueyen (UT2). This would serve as the optical spectroscopic arm of VST-based surveys, on a variety of astrophysical objects (QSOs, intermediate redshift clusters, etc.). Another avenue would be to build a new fully cryogenic multi-object capability, in order to pursue NIRMOS galaxy surveys to higher redshifts. This would be technically demanding (use of exchangeable cryogenic masks or perhaps programmable 2-D micro-shutter arrays) and potentially quite expensive, as only a truly wide-field capability (> 20′) could remain competitive in the NGST era.

IV. The VLT and Exoplanets

This domain is rapidly developing as a major new frontier in observational astronomy. We are already investing heavily at ESO with a variety of observing techniques: statistics of planetary systems from gravitational micro-lensing with ΩCAM at the VST; radial velocity detection with HARPS at the La Silla 3.6-m; proper-motion detection with PRIMA at the VLT combined interferometric focus. Niche observations will occasionally be addressed with VLT instruments, e.g. radial velocity measurement of faint promising candidates with UVES and, possibly, direct detection of 51 Pegasi-type planets with CRIRES.

V. VLT vs. NGST

The NGST will basically crush any ground-based competition in two domains:

– low-resolution spectroscopy ($\Re = 100$ to 1000) at <u>all</u> $\lambda > 2.2$ µm, and probably up to 25–30 µm;

– medium-field (~ $5' \times 5'$) imagery at all $\lambda > 0.6$ µm, except if/when efficient spectral hole burning filters could suppress all night sky emission in a fair fraction of the 0.6–1.8 µm wavelength range, which is far from technically ensured at present.

On the other hand, whole observational domains will stay largely untouched, especially:

– large-field surveys for building massive data base a la SLOAN Survey and/or for the detection of rare objects;

– high spectral resolution work, with presently at the VLT, UVES, CRIRES and the higher resolution modes of VISIR.

VI. Conclusion: Potential Avenues

We are led to a number of potentially interesting new instrumental avenues, namely:

• A "Phase II SINFONI" for 1.1 to 2.5 µm integral field spectroscopy with a larger field and higher, but still moderate order, Adaptive Optics corrections as a single (faint) object capability competitive w.r.t. NGST;

• A much more technically ambitious optical version of the above, using higher-order Adaptive Optics technology developed in the framework of the 100-m-diameter OWL feasibility study, and going down to 0.5 µm or even below;

• A cryogenic extension of NIRMOS up to the K band for higher z galaxy surveys;

• A multi-fibre, half a degree field, spectroscopic survey capability;

• A super-UVES ($\Re$ up to 10^6), using high-order Adaptive Optics, for the study of the local Interstellar Medium.

This is not a shopping list, but only a proposed preliminary set of basic facts and guiding principles. Hopefully, this is also the very first step towards building in the coming years a flexible plan for an orderly renewal of the first generation of VLT instruments. A first round of discussions has been done within the ESO Faculty and the issue is now in the hand of our community. This paper is in fact a slightly edited version of a report presented last May to the ESO Scientific and Technical Committee (STC), which has set up a subcommittee to investigate this whole issue.

gmonnet@eso.org

[1] Stellar continuum below a rest frame wavelength of 912 Å goes sharply to essentially a zero value, because of huge absorption by neutral hydrogen in the line of sight. This characteristic spectral signature, shifted to wavelengths accessible from the ground by the redshift of the object, is a major cosmological tool since the seminal work of Steidel. An e.g. B dropout is a galaxy whose continuum drops to zero in the B band and below.

The VLT Data Quality Control System

P. BALLESTER, A. DISARÒ, D. DORIGO, A. MODIGLIANI, J.A. PIZARRO DE LA IGLESIA

Conducting service observing at large ground-based observatories profits from delivering standard data products to the users. The operational applications needed to quantitatively assess VLT calibration and science data are provided by the VLT Quality Control system (QC). In the Data Flow observation life-cycle diagram ([2], [3], [4], http://www.eso.org/projects/dfs), QC relates data pipeline processing and observation preparation. It allows the ESO Quality Control Scientists of the Data Flow Operations group to populate and maintain the pipeline calibration database, as well as to measure and verify the quality of observations. The QC system also provides models allowing users to predict instrument performance, and the Exposure Time Calculators are probably the QC applications most visible to the astronomical community.

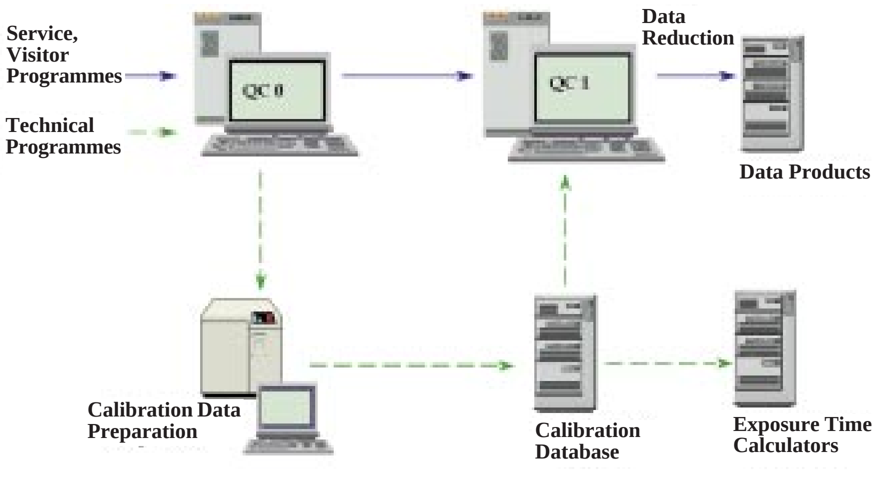


Figure 1: The VLT Data Quality Control system.

The Quality Control system is needed to cope with the large data volumes of the VLT, the geographical distribution of data handling, and the parallelism of observations executed on the different unit telescopes and instruments. Figure 1 shows how internal QC applications are used at the different stages of the observation life cycle. Technical programmes are executed and provide raw calibration data. These data are processed and prepared for use by the instrument pipelines. The McCreator application provides a unified interface to the instrument pipelines for the preparation of such reference calibration data. These data are then stored in the observatory archive using the Calibration Database Manager and distributed to the operational pipelines and Exposure Time Calculators. During the course of operations, a number of parameters are tracked by the QC processes and allow the operations teams to verify the observation conditions (QC level 0) and the performance measured on pipeline processed data (QC level 1).

1. Predicting and Controlling the Instrument Performance

The choice of exposure time for scientific programmes usually depends on the estimation of the signal-to-noise ratio necessary to reach a given measurement accuracy. This can be evaluated using the on-line Web Exposure Time

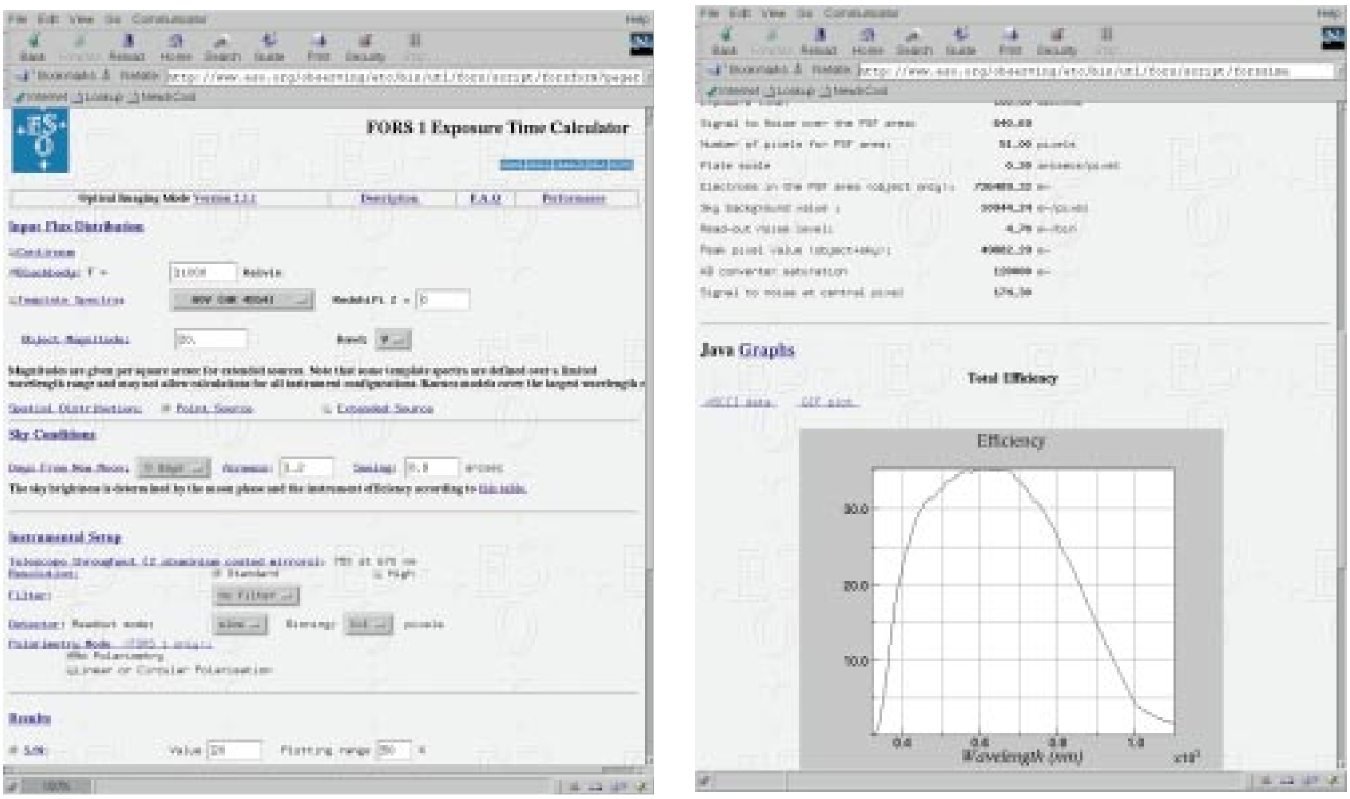


Figure 2: The FORS Exposure Time Calculator.

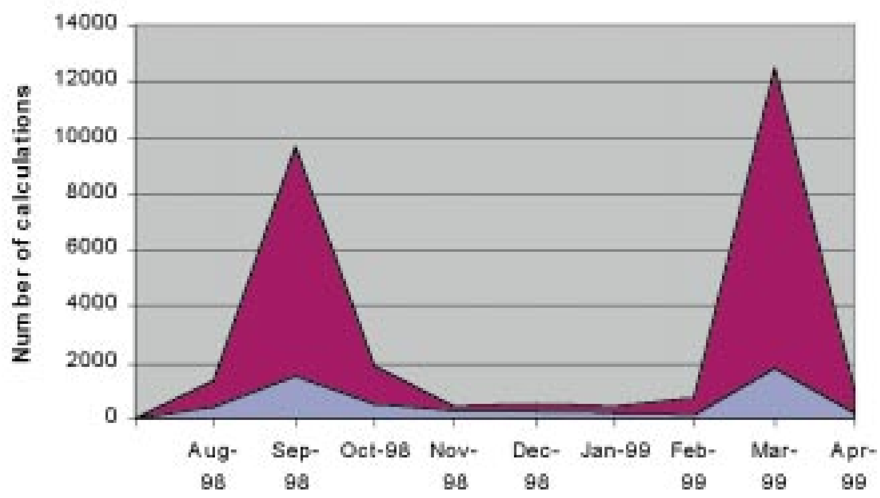


Figure 3: The ESO ETCs usage statistics over the first two VLT Call for Proposal periods.

Calculators (ETCs) provided for the VLT instruments, currently including FORS and ISAAC for the imaging and spectroscopy modes, as well as the NTT instruments SUSI, EMMI, SOFI, and the 2p2 Wide-Field Imager in La Silla. The Exposure Time Calculators have been offered for the VLT instruments since the first call for proposals for period 63 in August 1998. Figure 3 shows the usage statistics during the first two VLT periods. The blue curve represents internal use, and the red one the external usage, particularly important in the few weeks preceding the end of the proposal period, with a daily usage of about 1500 runs per day.

With the ETCs it is possible to compare the different options relevant to an observing programme, including instrument configuration, variable atmospheric conditions and observing parameters. Being maintained centrally on the ESO Web servers, the ETCs can always provide up-to-date information reflecting the known performance of the instrumentation. A single Web page (http://www.eso.org/observing/etc) gives access to all released ETCs. The tools are also a useful reference in the periods of instrument commissioning and in the first periods of service observing as they provide a reference for the expected performance of an instrument.

These programmes present an HTML/Java-based interface and consist of two pages. The observation parameters page includes the entry fields and choices for all parameters defining the observation: target information, expected atmospheric conditions, instrument configuration, observation parameters such as exposure time or signal-to-noise, and results selection. The target information section presents a choice of spectral flux distributions such as template spectra, blackbody, or single emission lines, magnitude scaling, and spatial distributions options like seeing-limited or extended sources. In the sky conditions section, the user can assign the expected moon phase, airmass, and seeing conditions as requested in the Phase II Proposal Preparation system [1]. Four classes of models are currently offered for optical or infrared, imaging or long-slit spectroscopy instruments. The target information and atmospheric conditions windows are identical for each class of instruments. The result page presents the a summary description of the observation, including number of counts for the object and the sky, signal-to-noise ratios, instrument efficiencies, PSF size, and the probability of realisation of the requested atmospheric conditions. Graphs are displayed within interactive Java applets for an easier manipulation. The graph results are also produced in different formats for further analysis and printing. Finally a summary of the input parameters is appended to the result page. Help files and documentation are provided on-line. A page of general information lists the latest updates and provides answers to Frequently Asked Questions. Detailed information concerning the spectral targets, atmospheric conditions, filter information, and usage of each section of the ETCs can be accessed by following the corresponding underlined links in the input and result forms.

2. Preparing Pipeline Calibration Frames with McCreator

The reduction pipelines associate reduction recipes and calibration data to the incoming observation data. While the reduction recipes usually remain stable over extended periods of time, the calibration data must be regularly updated to cope with always changing instrument and atmospheric properties. The nature and periodicity of the calibration exposures to be taken is defined in a calibration plan which for each mode of the instrument lists the observation blocks to be executed. Technical programmes are scheduled and produce on execution calibration data which are pre-processed by the pipeline and stored in a central repository. The pre-processed frames are then used to create reference calibration solutions. After certification the calibration solutions are copied to the Science Archive.

McCreator is a graphical interface application written in Tcl/Tk, which provides a front-end interface to pipeline and quality control modules such as the Data Organiser, Reduction Block Scheduler, and the Calibration Database. This tool is used internally by the Quality Control Scientists for the preparation of the pipeline calibration data. Calibration data can therefore be processed in a pipeline mode with an interface that allows the QC

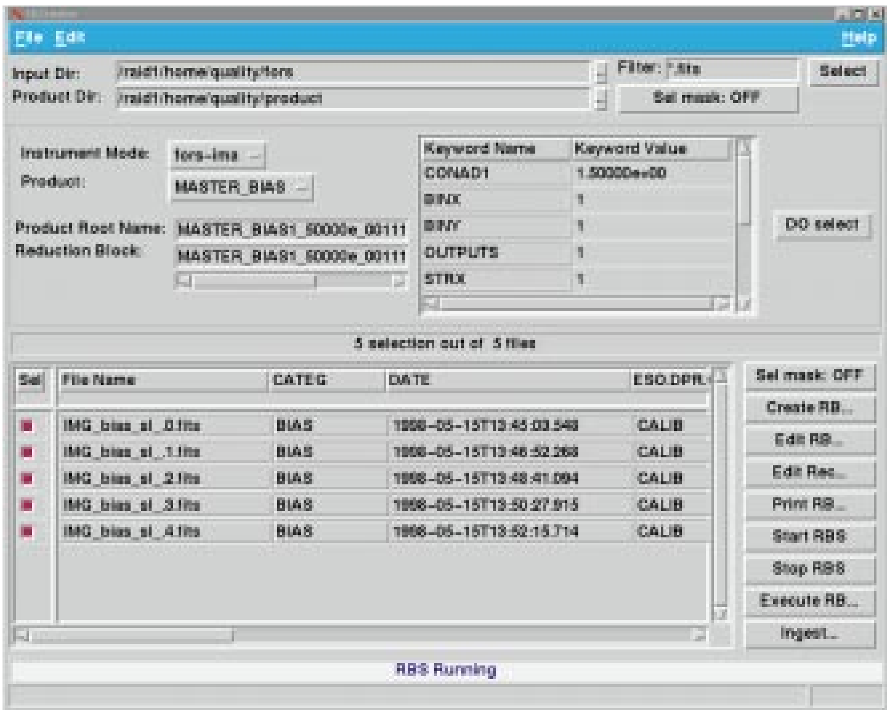


Figure 4: The McCreator main panel.

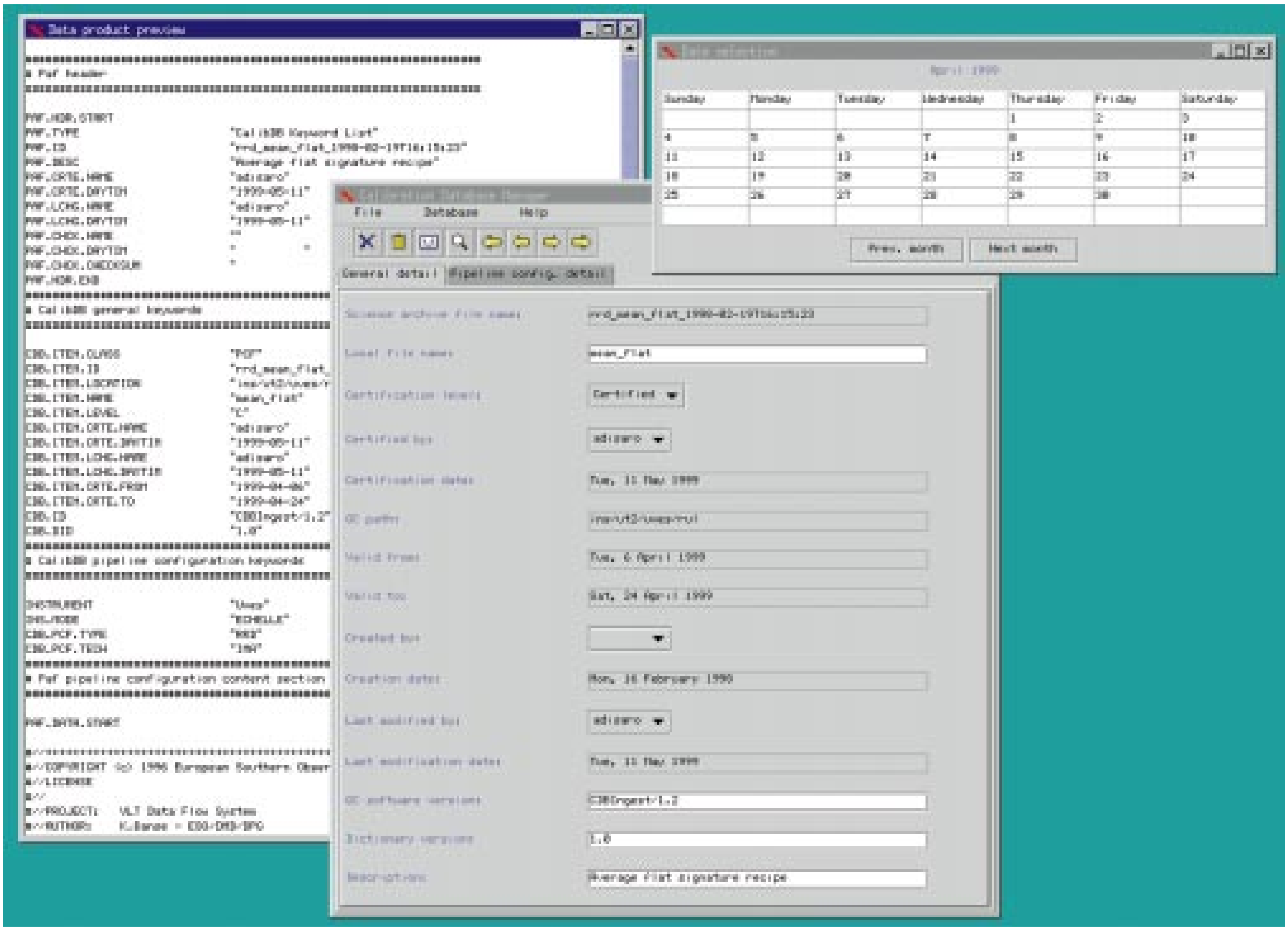


Figure 5: The Calibration Database Manager.

Scientist to adjust all steps of preparation of the reference calibration data.

3. The Calibration Database Manager

The Calibration Database includes a collection of observation data and reduction procedures representing as completely as possible the observing modes and configurations of the different VLT instruments. The Calibration Database Manager standard application for browsing, editing, populating and aligning the local calibration database contents. This application written in Java is the interface between the pipeline local calibration database and the ESO archive system. It allows the ESO Quality Control Scientists to request and submit files to the archive, and to structure calibration information to the formats supported by the pipeline and needed for long-term archival and trend analysis.

4. Assessing Observation Data

In the Data Flow System, Observation Blocks are queued for service observing and organised in a schedule managed on a long-, medium-, and short-term basis. The Short Term Scheduler is a decision support system which assists the operations manager in producing the observing time–line for one or a few nights. The main purpose of the scheduler is to maximise the utilisation of telescope time respecting a number of heterogeneous, user-defined constraints: target viewing, lunar illumination, weather and absolute and relative timing. The Science Archive stores all raw frames produced by the instruments, as well as reference calibration data, and log files including maintenance and ambient conditions logs. The Science Archive is available to archive researchers and astronomers for catalogue access and retrieval of scientific data as they become available after the end of the proprietary period

The verification of QC parameters allows us to assess observation data by comparing values measured on the raw or reduced data to target values specified by service observing users or by the observatory. Two levels of control are foreseen, called QC0 and QC1, differing by the need for calibration data. The level 0 of control is to verify that the user requested parameters, evaluated by the scheduler to trigger an observation, have been all respected during the observation. The parameters presently supported by the QC0 application in place for UT1 include airmass, moon distance, fractional lunar illumination, and seeing, and correspond to the observation constraints available in the Phase II Preparation System. This post-observation verification is performed independently and will catch variations of the meteorological conditions that might have occurred after the schedule evaluation. QC0 involves only access to the raw frames or the FITS header. It can therefore be applied to all frames produced by the instrument. The level 1 of control is the verification of the data by measuring parameters on reduced frames. It involves the association of calibration data and pipeline processing. Depending on the parameter controlled the processing is performed directly at the instrument pipeline after the observation or prior to the release of the user data package.

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pballest@eso.org

The VLT Software Workshop

E. ALLAERT, ESO

In May 1997 ESO has organised a first workshop on writing software for the VLT and its instruments, addressing thereby the needs of various consortia and also newly recruited ESO software engineers. Since then, the important milestones of the first light for Antu (UT1) and Kueyen (UT2) and a couple of instruments have been reached, showing that specifications have been met or even exceeded. This achievement was possible also thanks to the consistent and rigorous application of software engineering methodologies, use of common software and imposing software standards. All this makes the VLT software very homogeneous and robust.

Figure 1.

The first instruments (Test Camera, FORS and ISAAC) of course all use the same common base layers of software. They also show how important it is to have common concepts at a higher level, so that e.g. the same user interface (BOB) can be employed for all of them. The successful commissioning and operation of these instruments demonstrate that both in-house development (Test Camera and ISAAC) and development by consortia (FORS) can be suitable approaches. A clear requirement is surely a close collaboration between the Institutes and ESO. An integral part of that is ESO's commitment to provide and maintain the so-called VLT common software.

There is a lot more software in the makes for the VLT: while several VLT instruments and in particular the code driving them are currently being developed, others are in the preliminary or conceptual design phase. Also VLTI requires a considerable implementation effort. For that reason, ESO set up a second workshop on both VLT Control and Data Flow software, from Wednesday 21 April up to and including Friday 23 April 1999. The targeted audience were software engineers of ESO, consortia and contractors. Most of the software staff of the technical and DMD divisions contributed to the workshop, which was organised by P. Biereichel and myself.

Figure 2.

The first day most of the VLT Common Software components were introduced by means of a practical task: build an application that is compliant with the VLT control software standards. The second day consisted of several rather in-depth presentations of instrumentation software components, and several CCS software modules. There was also a show-around for UVES (which at that point was almost ready for shipment to Paranal) and the VLT Control Model (the computers and some other hardware used at Garching to simulate a VLT unit telescope). The third and last day was filled mainly with presentations on data-flow software, and some more tutorials about the panel editor and software engineering.

The participants were apparently not frightened by the information density as announced in the workshop's agenda, and a total of 38 engineers registered – about double the amount of the 1997 workshop. And the large majority of these 38 participants followed attentively and enthusiastically until the very end. Shortly before closing, a group picture was taken in the ESO headquarters reception area, in front of the auditorium where the presentations took place (**see photos**).

The handouts of the various presentations are also available in electronic format. You can access them via the URL http://www.eso.org/projects/vlt/sw-dev/workshop/. The same goes for the demo software used during some of these presentations.

We want to thank all participants for their interest, their questions and suggestions. This has been a good opportunity to "spread the word", introducing the concepts to some, re-enforcing methodologies for others, drawing the goal of writing VLT-compliant software a lot nearer.

Long-Term Spectroscopic Monitoring of Pulsating B Stars: a Tribute to the CAT

C. AERTS, P. DE CAT and L. EYER, Instituut voor Sterrenkunde, Leuven, Belgium*

1. Asteroseismology

Asteroseismology is a modern term for the study of the internal structure of multiply-periodic pulsating stars. If a large number of pulsation modes occurs, then the stellar interior can be probed from oscillation studies because the modes penetrate to various depths inside the star. The first very successful application of asteroseismology was presented for white dwarfs (Winget et al. 1991), which pulsate in high-order gravity (g-) modes.

Seismological studies of main-sequence stars are in a sense more interesting compared to those of white dwarfs, because they can provide us with important issues about the internal structure of stars that still have a long and interesting evolution ahead. Especially massive main-sequence stars are worth investigating, since accurate evolutionary tracks for the latter are still lacking.

Good candidates to perform asteroseismology of massive stars are the multiperiodic B-type pulsators, i.e. the β Cep stars and the slowly pulsating B stars. These two groups of stars provide us with the opportunity to study accurate masses, the extent of convective overshoot, and the internal rotation law observationally. The β Cep stars pulsate in pressure (p-)modes, which have a large amplitude at the stellar surface. The slowly pulsating B stars, on the other hand, can be viewed as main-sequence analogues of pulsating white dwarfs in the sense that they also pulsate in many high-order g-modes which penetrate deep into the star.

2. Monitoring Pulsating B Stars with the CAT

A nice recent review on the observational status of OB-type variables is presented by Baade (1998). We have been involved in numerous observing programmes of pulsating B stars. It concerns both photometric and spectroscopic runs with various telescopes (e.g. Aerts 1994).

2.1 β Cep Stars

While the first efforts of asteroseismology of β Cep stars are at hand (Dziembowski & Jerzykiewicz 1996, 1999), they have not been very successful up to now. The reason is that unambiguous mode identifications are not available. This is especially the case for the rapid rotators among the β Cep stars. In 1997, we have obtained the most extensive continuous data sets of high-quality spectra for the β Cep stars κ and λ Sco with the CAT. For each star, we obtained more than 400 profiles spread over 8 consecutive nights, each having a S/N ratio of over 500. Both stars were classified as β Cep stars in the seventies and rotate rapidly ($v \sin i > 100$ km/s). A detailed spectroscopic study is not available yet. We show in Figure 1 one night of our data for λ Sco in a grey-scale representation. The spectra reveal the presence of absorption dips that move partly through the profile from blue to red. Such moving patterns are not yet often found for β Cep stars for the simple reason that few rapid rotators among this group of variables have been the subject of detailed spectroscopic monitoring. Striking is the fact that the bumps do not move across the whole profile. Moreover, the line-profile variability is somewhat different during each of the 8 nights of the mission. This seems to suggest that multiperiodicity is present. On the other hand, the moments of the line profiles are clearly dominated by one period of 0.2137 days. This period is in full agreement with the result derived from photometric data by Lomb & Shobbrook (1975). The grey-scale representations point out that the pulsation mode must be of a complicated tesseral nature, contrary to Lomb & Shobbrook's suggestion that the star pulsates radially. The detection of tesseral modes in β Cep stars is scarce and is important in view of a confrontation of observational

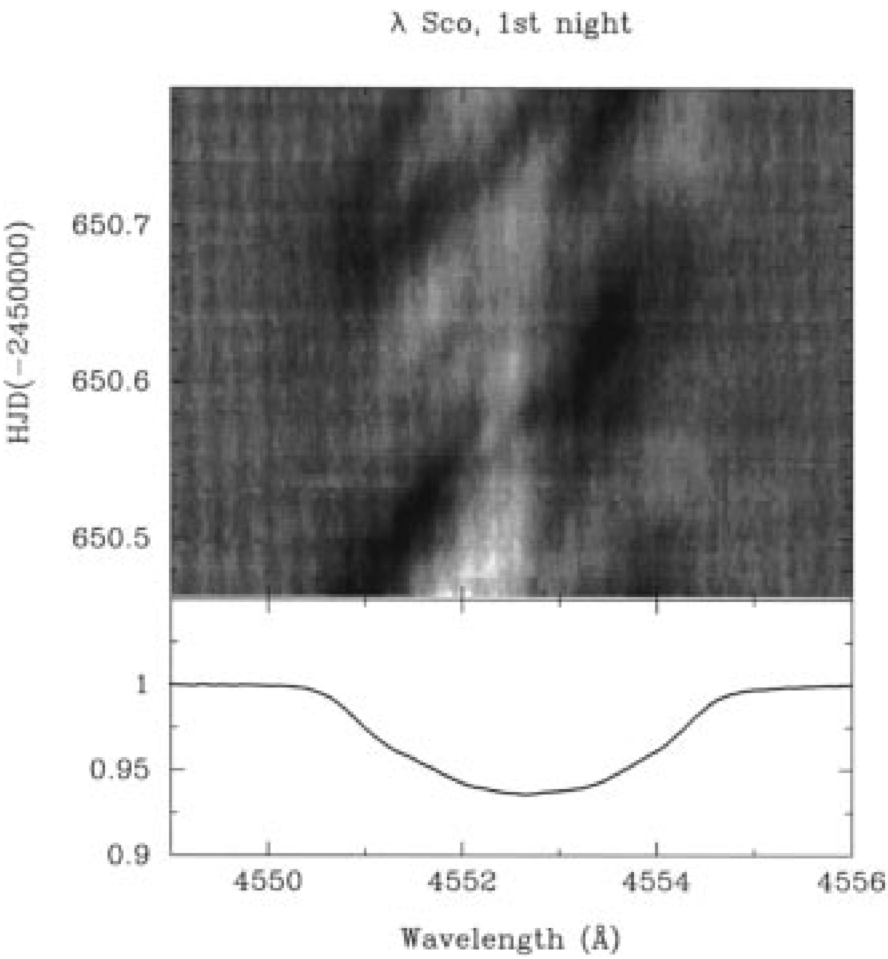

Figure 1: Grey-scale representation of the first night of our obtained line-profile variations of λ Sco. Each wavelength bin of the residual spectra with respect to the average profile of the entire run (8 nights) is given a grey value. White denotes local flux emission and black local flux absorption compared to the average profile, which is given in the lower panel.

*Postdoctoral Fellow, Fund for Scientific Research, Flanders.

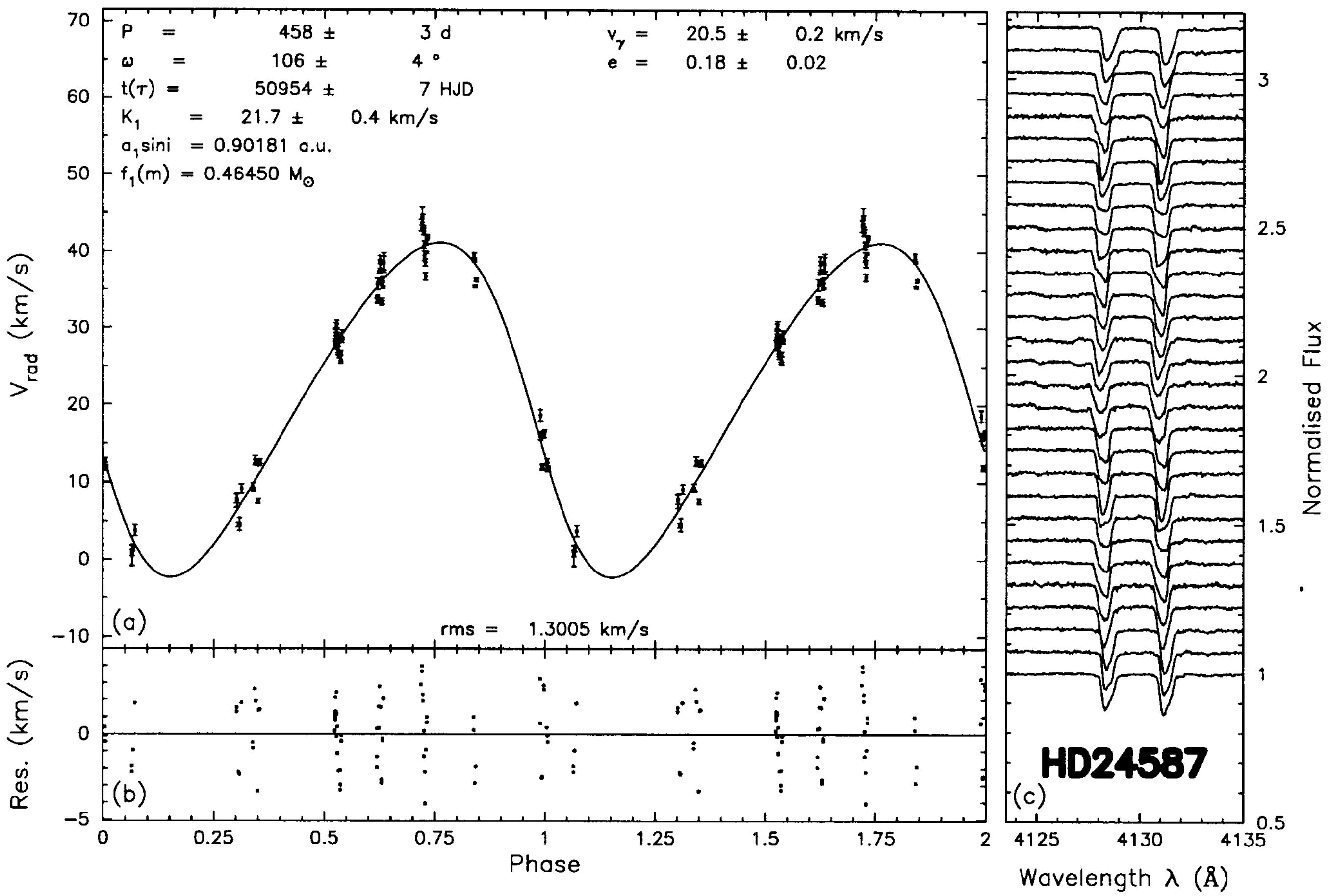

Figure 2: (a) The radial velocity variations of the slowly pulsating B star HD 24587. The dots represent the observations, and the full line is the orbit for the parameters that are listed. (b) The residuals after prewhitening with the orbital solution given in panel (a). (c) The line-profile variations of the main component of the system.

results with the recent theoretical pulsation models for β Cep stars proposed by e.g. Dziembowski & Pamyatnykh (1993). Although we still have to complete a detailed mode identification for this star, this example clearly shows that dedicated high-resolution spectroscopy is needed in order to derive accurate velocity parameters. The CAT was perfectly suited to obtain such data.

2.2 Slowly pulsating B stars

The slowly pulsating B stars, being confirmed high-order g-mode pulsators, are the most promising early-type stars to apply asteroseismology. During a first CAT observing run more than 10 years ago, Waelkens (1987) could prove the existence of line-profile variability in two such stars. The data were not numerous at that time because the Reticon worked markedly slower than current CCDs. We recently re-addressed the study of line-profile variations in slowly pulsating B stars because of the possibility to apply seismology. Also, Hipparcos provided us with a large sample of new members of this class of variables (Waelkens et al. 1998). Many of them are sufficiently bright to be observed spectroscopically.

The observational study of these stars remains very challenging, despite the instrumental improvements. Indeed, the long beat periods (months/years) have to be covered with a sufficient amount of data to unravel all the beat phenomena. Nonetheless, we have started a systematic photometric and spectroscopic study of some 20 bright slowly pulsating B stars in 1996. The photometric data were obtained with the Swiss photometric telescope at La Silla in the course of 1997. The spectroscopic observations were performed with the CAT. Both telescopes were closed in the meantime. In total, we have gathered CAT data during more than 10 weeks, spread over more than two years. The most important results so far derived from our spectra are:

- the detection of line-profile variations on the expected time scales in all target slowly pulsating B stars,
- the finding that slowly pulsating B stars are not necessarily slow rotators, as was thought before our missions,
- the discovery that about half of the monitored slowly pulsating B stars are spectroscopic binaries.

Concerning the latter point, we show in Figure 2 the orbit derived for the star HD 24587. This star was not known to be a binary and has the longest orbital period among the sample. Several weeks of monitoring, spread over more than one year, were necessary to derive the orbital parameters. Besides the orbital motion, line-profile variability is clearly present in the observed profiles.

The first results of our long-term project are encouraging, since they suggest that our observations fulfil the expectations we had when starting this study. We refer to Aerts et al. (1998a, b, 1999) for subsequent reports on the progress of the analysis of the data. Much work still remains to be done and we expect to report on the definite results in a few years from now.

It is our intention to select the most interesting targets for very-long-term spectroscopic monitoring with CORALIE, the accurate spectrograph mounted on the new 1.2-m Swiss telescope at La Silla. Our first test runs with CORALIE were completed recently and our data show that this instrument is indeed a suitable alternative to continue our long-term project now that the CAT is no longer available. In Figure 3, we compare a CORALIE line profile of the Si II 4130Å line and the corresponding cross-correlation function for the slowly pulsating B star HD 215573 with a CAT/CES spectrum of the same spectral line. The integration times for both exposures were 17 (CORALIE) and 25 (CES) minutes. At present, we still have to work out a better mask (typical for a B-type star) to cross-correlate in a more efficient way, but it is clear that working with the cross-correlation profile instead of with the true spectrum will be better to identify the pulsation modes.

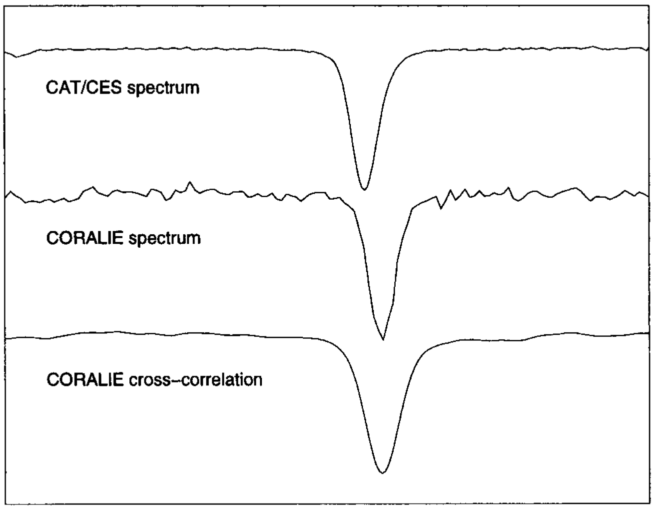

Figure 3: A Si II 4130Å line profile obtained with the CAT/CES is compared with one obtained with CORALIE and a cross-correlation profile derived from the CORALIE spectrum. Integration times were 25 minutes for the CAT spectrum and 17 minutes for the CORALIE spectrum.

For a previous application of mode identification in a pulsating star by means of cross-correlation functions we refer to Mathias & Aerts (1996). Another possibility to continue our monitoring is by means of FEROS. Up to now, we did not yet observe slowly pulsating B stars with this instrument, but we expect to find results comparable to those obtained with CORALIE.

3. Many Thanks

As already mentioned, a study as the one that we are undertaking is very challenging from an observational point of view. On the other hand, long-term monitoring is the only way to obtain meaningful results in the field of asteroseismology of early-type stars. Obviously, the OPC members judged that the scientific rationale of our proposals is important. We would like to thank both ESO and the Geneva Observatory for the generous awarding of telescope time to our long-term project.

We realise that the spectroscopic study of pulsating stars, one of the main subjects of our work in astronomy during the past 10 years, would not have been possible without an instrument like the CAT/CES. This combination of telescope and spectrograph was a cornerstone for the observational research performed at our institute, and several other astronomers, who now occupy key positions in important astronomical institutes, also made largely use of the CAT to develop their careers.

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A Procedure for Deriving Accurate Linear Polarimetric Measurements[1]

*H. LAMY and D. HUTSEMÉKERS**

Institut d'Astrophysique, Université de Liège, Belgium; e-mail: lamy@astro.ulg.ac.be, hutsemek@astro.ulg.ac.be

We present here a procedure written within the ESO MIDAS reduction package with the aim of deriving semi-automatically linear polarisation data from CCD images obtained with beam-splitters such as those available at the ESO 3.6-m telescope equipped with EFOSC2 or at the VLT equipped with FORS1. This method is adequate for point-like objects and was used for measuring quasar polarisation (cf. Hutsemékers et al. 1998). We also report on the detection of a significant image deformation effect, most probably due to the recent addition to EFOSC2 of a rotatable half-wave plate.

Polarimetry with EFOSC2

With EFOSC2, polarimetry is performed by inserting in the parallel beam a Wollaston prism which splits the incoming light rays into two orthogonally po-larised beams separated by a small angle (typically 20″). Every object in the field has therefore two images on the CCD detector (see Figure 1). In order to avoid any overlapping of different images and to reduce the sky contribution, an aperture mask is put at the focal plane of the telescope. The normalised Stokes parameters (NSPs), q and u, fully describing the linear polarisation, are then computed from the fluxes measured in the two orthogonally polarised images. Two frames with the Wollaston prism rotated by 45° are necessary to determine the NSPs. Additional frames may be considered although the quasi-perfect transmission of the Wollaston generally makes two orientations sufficient (Serkowski 1974; di Serego Alighieri 1989). Usually the orientations at 270° and 225° are taken and

$$q = \frac{I^{\mathrm{u}}_{270} - I^{\mathrm{l}}_{270}}{I^{\mathrm{u}}_{270} + I^{\mathrm{l}}_{270}}, \quad u = \frac{I^{\mathrm{u}}_{225} - I^{\mathrm{l}}_{225}}{I^{\mathrm{u}}_{225} + I^{\mathrm{l}}_{225}}, \qquad (1)$$

[1] See note on page 31.

*Chercheur Qualifié au Fonds National de la Recherche Scientifique (Belgium).

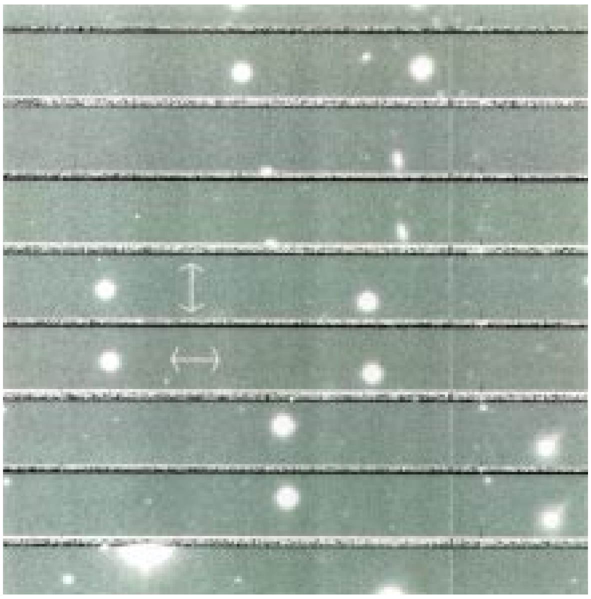


Figure 1: Example of a CCD frame obtained with EFOSC2, a Wollaston prism in the grism wheel and a mask at the focal plane of the telescope. Every object in the field has two orthogonally polarised images separated by ~ 20″ and called upper and lower images in the text. The arrows illustrate the direction of the polarisation of the two images. The y-axis is defined along the columns of the CCD, which is roughly the direction of the splitting. The detector was the Loral/Lesser CCD #40 with a pixel size of 0.160″ on the sky. The target was the quasar M08.02, observed on April 27, 1998 in the V filter with an exposure time of 300 s. It has a degree of polarisation p ≃ 1.4%.

where I^u_α and I^l_α respectively represent the integrated fluxes from the upper and the lower images of the object produced by the Wollaston prism set at a position angle α. The associated errors, σ_q and σ_u, are calculated by computing the errors from the read-out noise and the photon noise in the object and the sky background and then by propagating these errors in Eq.1. The degree of polarisation is given by $p = \sqrt{q^2+u^2}$ and the polarisation position angle by θ = 1/2 * arctan(u/q). The angles are measured relative to the instrument reference frame such that the observation of at least one polarimetric standard star is required for determining the polarisation position angle zero point.

Within this observing mode, the whole instrument has to be rotated, which means significant time-loss mainly due to re-pointing the objects. The insertion of a rotating half-wave plate (HWP) as the first optical element in the parallel beam significantly fastens the procedure by keeping EFOSC fixed (Schwartz & Guisard, 1995). Usually, four frames with the HWP orientated at 0°, 22.5°, 45° and 67.5° are taken and the NSPs are derived using the following formulae (e.g. di Serego Alighieri 1998):

$$q = \frac{R_q - 1}{R_q + 1} \quad \text{where } R_q = \frac{I^u_0/I^l_0}{I^u_{45}/I^l_{45}}, \qquad (2)$$

$$u = \frac{R_u - 1}{R_u + 1} \quad \text{where } R_u = \frac{I^u_{22.5}/I^l_{22.5}}{I^u_{67.5}/I^l_{67.5}},$$

I^u_β and I^l_β respectively denoting the integrated fluxes from the upper and the lower images of the object produced by the Wollaston prism. β is the position angle of the HWP. The polarisation degree, the polarisation position angle and the associated errors are calculated as above. In principle each NSP may also be evaluated from a single frame using Eq. 1 such that, if we call q_0 (resp. q_{45}) the NSP calculated from the fluxes measured on the frame obtained with the HWP set at position angle 0° (resp. 45°), we should have $q_0 \simeq -q_{45}$.

Since the polarisation observed in extragalactic objects is usually ~ 1%, a careful subtraction of the sky background and an accurate determination of the object intensities I^u and I^l are essential to achieve a good estimate of the NSPs. In the next section we describe a MIDAS procedure written with the aim of optimising these two constraints.

The Reduction Procedure

In order to accurately measure I^u and I^l, the first step is to subtract locally the sky background. Since the latter is usually polarised, this must be done independently for each orthogonally polarised image. For that purpose, two strips centered on the object are first extracted. Then the local sky is evaluated by fitting a bi-dimensional polynome to values of the background measured in small boxboxes free of cosmic rays and faint objects. The best results were obtained with polynomes of degree one. The small boxes are chosen in the upper and in the lower strips at exactly the same locations with respect to the object, taking into account a possible misalignment between the direction of the image splitting and the columns of the CCD.

Secondly, we noted after several trials that the usual standard aperture photometric methods available in MIDAS are not accurate enough for polarimetry: these procedures generally measure the total flux inside a given circle, taking entirely into account those pixels which are only partially contained in the circle. This is particularly problematic when the pixel size is large. Instead, we determine the center and the width of the object image at subpixel precision by fitting a bidimensional gaussian profile. Then, by means of a FORTRAN code, we integrate the flux in a circle of same center and arbitrary radius, taking into account only those fractions of pixels inside the circle. This was achieved on the basis of simple geometrical considerations. The NSPs may then be evaluated for any reasonable value of the aperture radius, expressed in units of the mean gaussian width $\sigma = (2\ln 2)^{-1/2}$FWHM/2, which is assumed to be identical for both the upper and lower images of the object. In order to take as much flux as possible without too much sky background, we adopt the radius R/σ = 2.5 which generally fulfils these requirements. Typical results obtained with the Wollaston prism only (i.e. without a HWP) indicate that, within the error bars, the measured NSPs are very stable against aperture radius variation, therefore giving confidence in the method.

With the aim of providing a semi-automatic and easy-to-use tool for extracting polarimetric data, two procedures have been implemented in MIDAS. The first one measures the intensities of the object and that of the background for any desired value of the aperture radius.

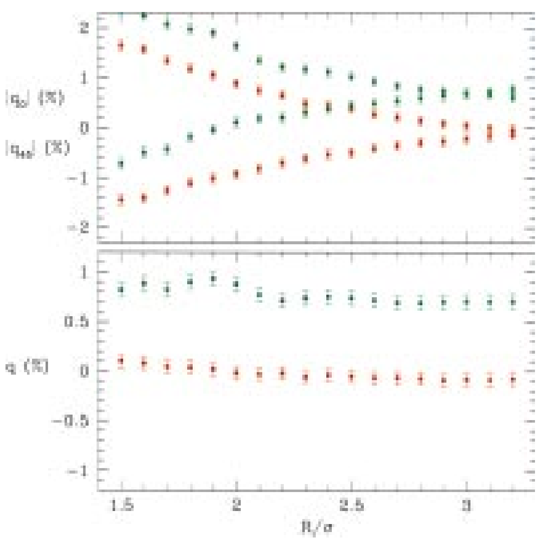
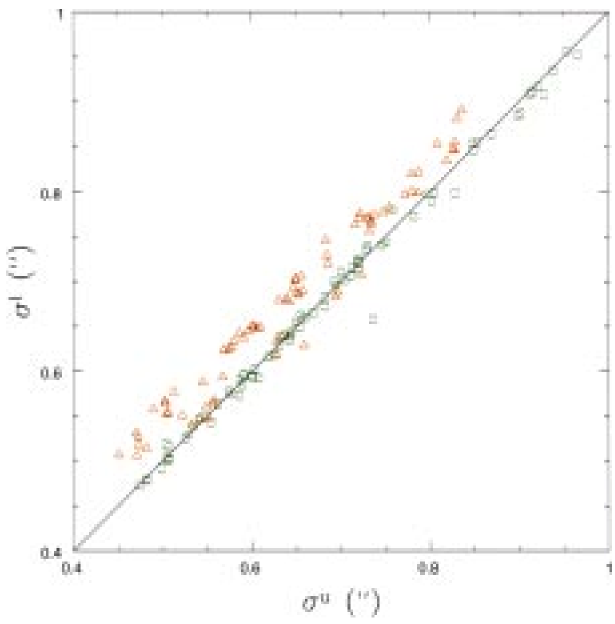


Figure 2: Upper panel: The normalised Stokes parameters, q_0 and q_{45}, are represented in absolute values as a function of the aperture radius expressed in units of the gaussian width of the image, for a polarised and an unpolarised quasar. These data were obtained on April 27–28, 1998 with EFOSC2 equipped with a 20″ Wollaston prism and a Half-Wave Plate set at 0° and 45°. The quasars were observed in the V filter with a typical exposure time of 300s for a given orientation. The pixel size was 0.130″ on the sky. Lower panel: The normalised Stokes parameter, q, computed according to Eq. 2 (see text). q is essentially stable against radius variation indicating that the effect described in the text is corrected.

Figure 3: The gaussian widths of the lower images, σ^l, are represented as a function of the widths of the upper ones, σ^u, for all quasars observed during the nights 27–28 April 1998. Note that four HWP orientations have been obtained for each object and are presented here. The green squares represent σ_x and the red triangles σ_y. Most of the objects show an elongation along the direction of the Wollaston splitting (y-axis). The gaussian widths are expressed in arcsecond. The lack of corresponding red triangles in the right top corner corresponds to the second image deformation described in the text, affecting objects with wider profiles only.



enough to minimise the effect. In this latter case, the radius $R/\sigma = 3$ is generally sufficient and the additional noise due to the background not too large. Note that, in fact, none of the two orthogonally polarised images is actually circular, as illustrated in Figure 4. But only the image deformations differentially affecting the upper and lower images have an effect on the NSPs measurements. It is important to emphasise that these effects were not visible on frames obtained previously with the Wollaston prism only, suggesting that the HWP is most probably responsible for the observed image deformations.

The image deformations described here appear much more complex than the expected behaviour due to the Wollaston chromatism only (e.g. di Serego Alighieri et al. 1989). Such an effect is important to further investigate and understand since it may affect imaging polarimetry with high spatial resolution instruments as will be available on the VLT.

The second one combines these measurements to provide the NSPs, the errors, the degree of polarisation and the polarisation position angle as a function of the aperture radius. The procedures can be made available as such to anyone interested.

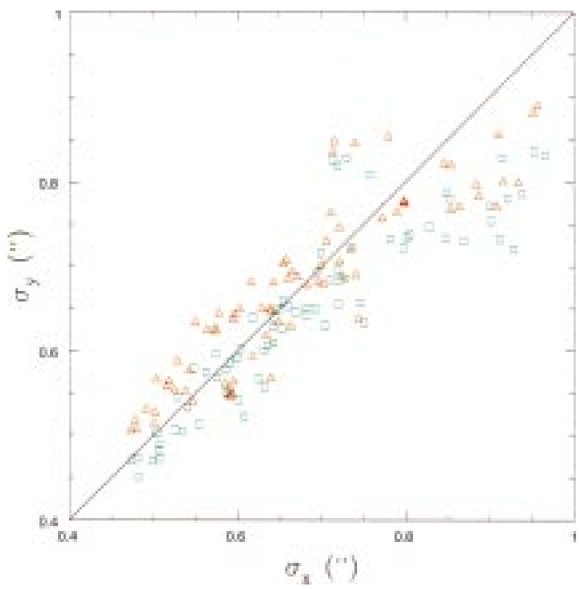
Image Deformations and Their Effect on the Measurements

While the dependence of the NSPs against radius variation is quite flat when using the Wollaston without HWP, a different behaviour is found when adding the HWP. As previously stated, q_0 and q_{45} should be identical in absolute value apart from a small difference due to instrumental polarisation. However, it appears that $|q_0|$ and $|q_{45}|$ measured for a given aperture radius significantly differ. This is illustrated in the upper panel of Figure 2: for small radii, $|q_0|$ and $|q_{45}|$ appear quite different (sometimes $\geq$ 1%), while they finally tend towards the same value as the radius increases. For $R/\sigma \geq 3$, they are equal within the error bars. The two curves have nearly symmetrical shapes with respect to the expected behaviour (i.e. a flat curve with $|q_0|$ and $|q_{45}|$ identical). This effect is detected for polarised and unpolarised objects.

By fitting a bi-dimensional gaussian profile to the object, we have measured the widths σ_x and σ_y of the upper and lower orthogonally polarised images of the object. Figure 3 represents σ^l_x (resp σ^l_y), measured from the lower image, as a function of σ^u_x (resp σ^u_y), measured from the upper image, for every CCD frame obtained during the nights April 27–29, 1998. It appears clearly that the lower images are systematically more elongated along the y-axis than the upper images, while their widths are nearly identical along the x-axis direction. The mean difference between σ^l_y and σ^u_y is ~ 0.08″. This difference is more or less constant whatever the mean width of the gaussian profile. It is also independent of the HWP position angle. As a consequence, for a given aperture radius, we measure less flux in the upper images than in the lower ones. Therefore, for small radii, $|q_0|$ appear larger and $|q_{45}|$ smaller than the actual values. As the aperture radius increases, the total flux of the lower image is progressively taken into account and this effect vanishes, $|q_0|$ and $|q_{45}|$ tending towards the same value, in agreement with the behaviour seen in Figure 2. Note that there are a few frames on which the object images have $\sigma^u_y \sim \sigma^l_y$ which precisely corresponds to those cases where the $|q_0|$and $|q_{45}|$ curves are more similar.

Fortunately, due to the fact that the image deformations are independent of the HWP orientation, this effect is well corrected when determining a given NSP by combining the intensities from two frames according to Eq. 2. This is illustrated in the lower panel of Figure 2 which shows the expected flat curves. We may therefore conclude that two frames with the HWP set at angles separated by 45° are necessary to accurately evaluate one of the NSPs. If only a single frame is obtained, the NSP has to be measured with a radius large

Figure 4: The gaussian width σ_y is represented as a function of σ_x for the upper (green squares) and the lower (red triangles) object images considering the same data as in Figure 3. The general trend is that upper images have $\sigma^u_x > \sigma^u_y$ while the lower images have $\sigma^l_x < \sigma^l_y$. For images with larger profiles, both images flatten ($\sigma_x > \sigma_y$), the difference being roughly constant.



Acknowledgements

This research is supported in part by contract ARC94/99-178 and by contract PAI P4/05. We also thank Marc Remy for providing us with the FORTRAN code.

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Translation of the Speech by H.E. the President of the Republic of Chile, Don Eduardo Frei Ruiz-Tagle, at the Inauguration of the Paranal Observatory, 5th March 1999

Ladies and Gentlemen,

It is a great satisfaction for me to inaugurate what is soon to become the most powerful telescope in the world, which will clearly respond to the essential human urge of exploring and learning about the origins and mysteries of the universe.

It will be here, in the middle of the Chilean desert, almost three thousand metres above sea level, that scientists from all over the planet will converge, to investigate the great issues of astrophysics, such as the origin, evolution and future of the universe; the formation of great structures, galaxies, stars and their life cycles, as well as the formation and evolution of planets, allowing us to learn about physical and chemical conditions appropriate for the development of life.

Historically, this northern region of Chile has supplied our major source of wealth, hidden in the entrails of the earth. Courageous copper miners continue, up to this day, to contribute to the development of this country, by supplying the world with valuable raw materials.

As from now, not only will the depths of the earth be explored from this region, but also the skies, thanks to the excellent climate that offers crystal clear skies, ideal for astronomy.

An extensive Association with Europe

Several aspects converge into this initiative, which I would like to highlight:

First, the Government of Chile and ESO have maintained, for over three decades, a relationship of extensive co-operation. As one of the most ambitious scientific projects of the century materialises today, we ratify this permanent vocation for service and collaboration.

This is a concrete example of the fact that the path towards our association with the main European nations is not restricted to financial or commercial issues. It also includes other significant challenges and tasks, which confer a transcendental sense to human beings and to their relation with the world.

Incorporation of Chilean Scientists to Astronomical Observation

Chilean scientists will gain special access to this centre of astronomical observation. This will constitute a substantial contribution to the work of our researchers, who will have the most modern technology at hand, for their studies, enabling their interaction with colleagues from other latitudes, thus contributing to scientific advancement.

Efforts of the Government in Favour of Science

This project is attached to the efforts of my government to promote science in our country. As we all know, we have increased our support to scientific research. We have established the Presidential Chairs, placing our trust in prominent researchers, who have been chosen by a high-level committee. I can modestly say that this initiative, started in this small country, where researchers have entered the home of the Presidents of Chile, with all dignity due to their task, stands out today within the international scientific community.

Before the end of my tenure, this effort will become consolidated and made evident in a transcendental project we call the Millennium Scientific Initiative, which has aroused interest and funding from the World Bank. This effort is designed to ensure that, within the next ten years, this country can incorporate national talents into the world's process of scientific advancement. Chile cannot remain behind. We must innovate our ways of dealing with science, encourage youth and, thus, leave a trail of our own in the world of the next millennium.

From this place, a magnificent evidence of man's capability, I would like to tell all Chileans that the Millennium Initiative has sparked extraordinary interest within the main scientific circles and international agencies. It is considered a prototype for developing countries to address their insertion into one of the most important aspects of globalisation, that is to say, scientific discovery.

Final Words

Ladies and gentlemen, I would like to congratulate all those who have made the concretion of this initiative possible, certainly including the Chilean technical and professional staff who participated in the construction of these magnificent facilities. I feel proud, as a Chilean, that this desert-like region of our country will render, to humanity, the possibility of deciphering the countless mysteries that have challenged mankind throughout history.

Scientists will observe, from this desert, these blue, starlit skies. We, Chileans, are opening our eyes and our minds, through knowledge, education and our active participation in the exploration of new frontiers. Let us continue to think big, let us continue to project ourselves into the third millennium, continue our commitment with our educational reform, making decisions in favour of people. This is how the barriers that separate us from development will be overcome.

Thank you very much.

Publications in Refereed Journals Based on Telescope Observations

J. BERGERON and U. GROTHKOPF, ESO

ESO's broad objective is to provide the astronomical communities in the member states with first-class optical-infrared facilities. During the past few years, major efforts were dedicated to the refurbishment and upgrading of all the telescopes at the La Silla Observatory as well as the restructuring of the Observatory in telescope and service teams.

The effectiveness of an observatory can be measured by its scientific productivity. To this end, we conducted a statistical study of the publications based on observations with ESO and other worldwide major telescopes during the 5-year period 1994–1998. These statistics (see Table below) clearly demonstrate the achievements of the ESO users' community in the use of the La Silla telescopes.

There is a striking increase by about a factor of 2 in the number of publications per year over the least 5 years for the larger La Silla telescopes as well as for the La Silla facilities as a whole. This is the strongest positive trend among all the 4-m-class telescopes, some of which have at best maintained their number of publications. The La Silla Observatory has become the most scientifically productive observatory in the world in terms of publications in refereed journals. The total number of publications per year of the 3.6-m telescope is now as high as that of the 4.2-m WHT, far above any other 4-m-class telescopes. It is expected that in the coming years this will also be the case for the NTT with its first-class instrumentation, since its yearly publications increased by a factor larger than 2 between 1995 and 1997 (results from observing missions conducted before the upgrade project).

Number of Publications in Refereed Journals by Telescope

Telescope	1994	1995	1996	1997	1998
ESO 3.6-m		52	85	101	115
ESO NTT 3.5-m		43	77	93	77
ESO 2.2-m		53	59	81	73
All La Silla Telescopes	219	220	367	393	419
AAT 3.9-m (a)		59	87	84	80
CFHT 3.6-m	93	78	74	72	
CTIO 4-m (b,c)		75	91	64	59
All CTIO Telescopes (b,c)		171	194	135	152
HST (excl. HST Archive papers)	158	203	233	250	284
HST (incl. HST Archive papers)	162	217	269	289	344
Kitt Peak 4-m Telescope (d)		74	73	62	52
Kitt Peak WIYN 3.5-m) (d)				13	28
All Kitt Peak Telescopes (d)		276	299	270	270
:					
ENO William Herschel Telescope 4.2-m	78	90	100	113	118
ENO Isaac Newton Telescope 2.5-m	63	81	84	77	72
ENO Nordic Optical Telescope 2.5-m	18	20	26	36	37
All ENO Telescopes (e)		201	231	239	253

(a) From 1 July previous year to 30 June current year
(b) From 1 August previous year to 31 July current year
(c) Refereed journals and conference proceedings
(d) From 1 October previous year to 30 September current year
(e) ENO Telescopes: Isaac Newton Group of Telescopes, Instituto de Astrofísica de Canarias Telescopes, Nordic Optical Telescope

Sources

The range of journals screened in order to compile the bibliographies depends on their availability in the corresponding library.

- ESO: Database of publications from the ESO users community (ESO staff and visiting astronomers; database maintained by A. Treumann, atreuman@eso.org). Statistics include only articles based on previously unpublished data.
- AAT: AAO Annual Reports 1994/95–1997/98. Statistics include also articles based on previously published data.
- CFHT: CFHT Web pages at http://www.cfht.hawaii.edu/Science/Publications/ Statistics include only articles based on previously unpublished data.
- CTIO: CTIO publications statistics as listed in the Annual Reports to the National Science Foundation; figures provided by Elaine Mac-Auliffe (mac@ctios1.ctio.noao.edu). Statistics are compiled by checking conference proceedings and those journals subscribed to by the observatory. Statistics include only articles based on previously unpublished data.
- HST: Statistics provided by STScI librarian Sarah Stevens-Rayburn (library@stsci.edu). Statistics include only articles based on previously unpublished data (except line "incl. HST Archive papers").
- Kitt Peak: Lists received from Kitt Peak librarian Mary Guerrieri (maryg@noao.edu). Kitt Peak includes all articles that explicitly mention use of one or more KPNO telescopes. Statistics can include articles based on previously published data.
- ENO: Isaac Newton Group papers provided by Janet Sinclair (jes@mrao.cam.ac.uk). IAC publications: lists available on the WWW (http://www.iac.es/gabinete/inves/publica/pi99.htm), further explanations received from Monica Murphy (mem@iac.es), Judith Araoz (jav@ll.iac.es) and Tanja Karthaus (tanja@ll.iac.es). NOT: Nordic Optical Telescope Triennial Report (1995–1997) and Annual Report 1998.

ESO at the Hannover Fair

C. MADSEN, ESO

The Hannover Fair is the world's largest industrial fair. Each year more than 300,000 visitors from all over the world attend this major event which occupies 30 large exhibition halls. This year, about 7300 enterprises from 63 countries demonstrated their latest products and services, either at individual stands or within 'national' information stands.

Every year, one country is awarded a special status as the "Partner Country" of the Fair. In 1999, Chile enjoyed this status and this country presented itself and its achievements in a 1700 square metre 'pavillon' inside of Hall 4.

Figure 1: Ms. Edelgard Bulmahn, German Federal Minister for Education, accompanied by her aides, during the visit to the ESO exhibition.

In this framework and as a fitting illustration of the good relations between Chile and Europe, ESO was invited by the Chilean Ministry of Foreign Affairs to present itself, its activities in Chile and the astronomical research conducted by the scientific community. This dedicated ESO exhibition was located at the entrance to the pavilion and included a 26-m-long corridor ultimately leading up to a first floor 'market area' devoted to Chilean commercial products. The left-hand side of the corridor featured large pictures of the ESO sites and telescopes, whereas the right-hand side described the climate and geology of Chile by means of pictures and texts. An 8-m-long panoramic colour photo of the Milky Way was attached to the ceiling to illustrate the outstanding observing conditions found in the Chilean desert. On a platform by the end of the corridor, panels and short videos dealt with some of the key astronomical questions and challenges for the VLT. A model of the VLT was on display and the new ESO VLT video caused several 'traffic jams' in the corridor as many visitors paused to see the film in its entire length.

The ESO exhibition was opened on April 19 with a formal visit by the President of Chile, Don Eduardo Frei Ruiz-Tagle, who demonstrated expert knowledge of technology and science at ESO, together with Mr. Gerhard Glogowski, Prime minister of Lower Saxony. On the following day, Ms. Edelgard Bulmahn, the German Federal Minister for Research, Mr. Werner Müller, Federal Minister of Economics and Ms. Heidi Merk, Deputy Prime minister of Lower Saxony, paid visits to the ESO exhibition.

By April 24, when the fair closed, more than 20,000 people had passed through the ESO area, leaving behind an exhausted, but most satisfied ESO staff.

Figure 2: View of the ESO 'corridor'.

ANNOUNCEMENTS

PERSONNEL MOVEMENTS

International Staff

(1 April 1999 – 30 June 1999)

ARRIVALS

EUROPE

BLOCK, Roland (D), Personnel Officer/Head of Personnel
BROADHURST, Thomas (UK), User Support Astronomer
CRISTIANI, Stefano (I), Instrument Scientist/Astronomer
DORN, Reinhold (D), CCD Detector Specialist
FUCHS, Rainer (D), Legal Advisor
GEIMER, Christoph (D), Electronics Technician
GIANNONE, Gino (I/CH), Software Engineer
HUXLEY, Alexis (GB), VLT Software System Manager for UNIX Computers
JUNG, Yves (F), Scientific Applications Developer
REYES, Javier (E), Electronics Engineer
ROSATI, Piero (I), VLT Programme Scientist
SCHÖLLER, Markus (D), VLTI Instrument Scientist
SIVERA, Paola (I), Software Engineer
STRÖBELE, Stefan (D), Adaptive Optics Laboratory Engineer
VEDSOE, Lone (DK), Accounting Assistant
VERNET, Joël (F), Coopérant ST-ECF
ZAMPIERI, Stefano (I), Archive System Designer and Database Engineer

CHILE

BRILLANT, Stéphane (F), Fellow
KAUFER, Andreas (D), Operations Staff Astronomer
LERNER, Mikael (S), SEST Microwave Engineer
RANTAKYRÖ, Fredrik (S), Fellow
SZEIFERT, Thomas (D), Operations Staff Astronomer

DEPARTURES

EUROPE

ANSORGE, Wolfgang (D), VLT Product Assurance Manager/Safety Manager
GERDES, Rolf (D), Deputy Group Leader of the Optical Detector Group
ZAIEPOUR, Houri (F), Archive System Designer/Engineer
ROSATI, Piero (I), Fellow
VERNET, Joël (F), Student
BALESTRA, Andrea (I), Associate
STRÖBELE, Stefan (D), Student

CHILE

PERSSON, Glenn (S), SEST Software Engineer

Local Staff – Chile

(February–June 1999)

ARRIVALS

GARCIA, Enrique, Electronics Technician
URETA, Eugenio, Construction Group Leader
HERRERA, Gabriel, Maintenance Mechanical Technician
LECAROS, Fernando, Telescope/Instruments Operator
LOPEZ, Ariel, Telescope/Instruments Operator
MONTANO, Nelson, Maintenance Mechanical Engineer
FLORES, Erito, Maintenance Mechanical Engineer
KASTINEN, Ismo, Telescope/nstruments Operator
MCKINSTRY, Christopher, Telescope/Instruments Operator

DEPARTURES

MARÍN, Héctor, Dibuj. Diseñador/Supervisor de Terreno
MORENO, Nicolás, Telescope/Instruments Operator
RICHARDSON, Felipe, Software Engineer/Developer
PIZARRO, María, Bilingual Secretary (VLT-SB Project)

ESO Fellowship Programme 2000

The European Southern Observatory (ESO) awards up to six postdoctoral fellowships tenable at the ESO Headquarters, located in Garching near Munich, and up to six postdoctoral fellowships tenable at ESO's Astronomy Centre in Santiago, Chile. The ESO fellowship programme offers a unique opportunity to participate in the activities of observational astronomy while pursuing a research programme with state-of-the-art facilities.

ESO facilities include the Very Large Telescope (VLT) Observatory on Cerro Paranal, the La Silla Observatory, and the astronomical centres in Garching and Santiago. At La Silla, ESO operates eight optical telescopes with apertures in the range from 0.9m to 3.6m, the 15m SEST millimetre radio telescope, and smaller instruments. The VLT consists of four 8-m diameter telescopes, the first of which is now fully operational. The second telescope had its first light in April 1999 and will be fully operational on 1st April 2000. Both the ESO Headquarters and the Astronomy Centre in Santiago offer extensive computing facilities, libraries and other infrastructure for research support. The Space Telescope European Coordinating Facility (ST-ECF), located in the ESO Headquarters building, offers the opportunity for collaborations. In the Munich area, several Max-Planck Institutes and the University Observatory have major programmes in astronomy and astrophysics and provide further opportunities for joint programmes. In Chile, astronomers from the rapidly expanding Chilean astronomical community collaborate with ESO colleagues in a growing partnership between ESO and the host country's academic community. The main areas of activity at the Headquarters and in Chile are:

- research in observational and theoretical astrophysics;
- construction and management of the VLT;
- development of the interferometer and adaptive optics for the VLT;
- operation of the Paranal and La Silla observatories;
- development of instruments for the VLT and La Silla telescopes;
- calibration, analysis, management and archiving of data from ESO telescopes;
- fostering co-operation in astronomy and astrophysics within Europe and Chile.

In addition to personal research, fellows spend a fraction of their time on the support or development activities mentioned above:

In Garching, fellows are assigned for 25% of their time to a technical or instrumentation group, a user support group or a telescope-operation team in Chile. The fellowships are granted for one year with the expectation of a renewal for a second year and exceptionally a third year.

In Chile, the fellowships are granted for one year with the expectation of a renewal for a second and third year. During the first two years, the fellows are assigned to a Paranal operation group or a La Silla telescope team. They support the astronomers at a level of 50% of their time, with 80 nights per year at either the Paranal or La Silla observatory and 35 days per year at the Santiago Office. During the third year two options are provided. The fellows may be hosted by a Chilean institution and thus be eligible to propose for Chilean observing time on all telescopes in Chile; they will not have any functional activity. The second option is to spend the third year in Garching where the fellows will then spend 25% of their time on the support of functional activities.

The basic monthly salary will be not less than DM 4853 to which is added an expatriation allowance of 9–12% in Garching, if applicable, and up to 40% in Chile. The remuneration in Chile will be adjusted according to the cost of living differential between Santiago de Chile and Munich. The fellow will also have an annual travel budget, for scientific meetings, collaborations and observing trips, of approximately DM 12,000.

Fellowships begin between April and October of the year in which they are awarded. Selected fellows can join ESO only after having completed their doctorate.

Applications must be made on the ESO Fellowship Application Form. The form is available either at URL http://www.hq.eso.org/gen-fac/adm/pers/vacant/fellow.html or from the address below. The applicant should arrange for three letters of recommendation from persons familiar with his/her scientific work to be sent directly to ESO. Applications and the three letters must reach ESO by October 15, 1999.

Completed applications should be addressed to:

European Southern Observatory
Fellowship Programme
Karl-Schwarzschild-Str. 2, D-85748 Garching bei München, Germany

Tel.: 0049-89-32006-219 – Fax: 0049-89-32006-497 – E-mail: ksteiner@eso.org

Contributed Software by Observers in the ESO Community

ESO welcomes the efforts of observers in the ESO Community to develop new procedures for observing or for data reduction.

Such procedures however, must be tested and integrated into the ESO data analysis environment before they become part of the official Data Flow System Pipeline supported by ESO.

ESO would encourage the authors to submit such packages to the “Contributed Software” section of ESO MIDAS.

List of Scientific Preprints

(April–June 1999)

1320. G.A. Wade, G. Mathys, P. North: The Ap Spectroscopic Binary HD 59435 Revisited. *A&A*.
1321. P. Rosati et al.: An X-Ray Selected Galaxy Cluster at z = 1.26. *AJ*.
1322. F.R. Ferraro, B. Paltrinieri, R.T. Rood, B. Dorman: Blue Straggler Stars: The Spectacular Population in M80. *ApJ*.
1323. M.F. Sterzik, J.M. Alcalá, E. Covino, M.G. Petr: New T Tauri Stars in the Vicinity of TW Hydrae. *A&A*.
1324. R.T. Rood et al.: The Luminosity Function of M3. *ApJ*.
1325. C.L. Sarazin et al.: ROSAT HRI X-Ray Observations of the Open Globular Cluster NGC 288. *ApJ*.
1326. J.U. Fynbo, P. Møller, S.J. Warren: Extended Lyα Emission from a Damped Lyα Absorber at z = 1.93, and the Relation Between DLAs and Lyman-Break Galaxies. *MNRAS*.
1327. F. Marchis and S. Cuevas: Optical Tolerances of Active Telescope Architectures from Adaptive Optics. *Revista Mexicana de Astronomía y Astrofísica*.
1328. Th. Rivinius, S. Štefl and D. Baade: Central Quasi-Emission Peaks in Shell Spectra and the Rotation of Disks of Be Stars. *A&A*.
1329. P.E. Nissen, D.L. Lambert, F. Primas, V.V. Smith: Isotopic Lithium Abundances in Five Metal-Poor Disk Stars. *A&A*.
1330. F. R Ferraro, M. Messineo, F. Fusi Pecci, M. A. De Palo, O. Straniero, A. Chieffi, M. Limongi: The Giant, Horizontal and Asymptotic Branches of Galactic Globular Clusters. I. The Catalog, Photometric Observables and Features. *AJ*.

The ESO MESSENGER is published four times a year: normally in March, June, September and December. ESO also publishes Conference Proceedings, Preprints, Technical Notes and other material connected to its activities. Press Releases inform the media about particular events. For further information, contact the ESO Education and Public Relations Department at the following address:

EUROPEAN
SOUTHERN OBSERVATORY
Karl-Schwarzschild-Str. 2
D-85748 Garching bei München
Germany
Tel. (089) 320 06-0
Telefax (089) 3202362
ips@eso.org (internet)
URL: http://www.eso.org

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NEW ESO PROCEEDINGS AVAILABLE

The Proceedings of the ESO/OSA Topical Meeting on

Astronomy with Adaptive Optics – Present Results and Future Programs

(ESO Conference and Workshop Proceedings No. 56)

were published this spring.

The price for the 742-page volume, edited by D. Bonaccini, is DM 100.— (prepayment required).

If you wish to acquire the proceedings, you should send your cheque to the ESO Financial Services, or transfer the amount of DM 100.— to the ESO bank account 2102 002 with Commerzbank München (BLZ 700 400 41).

Please do not forget to indicate the title of the proceedings and/or the number of the ESO Conference and Workshop proceedings (**No. 56**).

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