ESO
Annual Report 2004

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presented to the Council by the
Director General
Dr. Catherine Cesarsky

ESO is the foremost intergovernmental European Science and Technology organisation in the field of ground-based astrophysics. It is supported by eleven countries: Belgium, Denmark, France, Finland, Germany, Italy, the Netherlands, Portugal, Sweden, Switzerland and the United Kingdom.

Created in 1962, ESO provides state-of-the-art research facilities to European astronomers and astrophysicists. In pursuit of this task, ESO's activities cover a wide spectrum including the design and construction of world-class ground-based observational facilities for the member-state scientists, large telescope projects, design of innovative scientific instruments, developing new and advanced technologies, furthering European co-operation and carrying out European educational programmes.

ESO operates at three sites in the Atacama desert region of Chile. The first site is at La Silla, a mountain 600 km north of Santiago de Chile, at 2 400 m altitude. It is equipped with several optical telescopes with mirror diameters of up to 3.6-metres. The 3.5-m New Technology Telescope (NTT) was the first in the world to have a computer-controlled main mirror.

Whilst La Silla remains one of the scientifically most productive observing sites in the world, the Paranal site with the Very Large Telescope Array (VLT) is the flagship facility of European astronomy. Paranal is situated about 130 km south of the town of Antofagasta in Chile, 12 km inland from the Pacific Coast in what is probably the driest area in the world. Scientific operations began in 1999 and have resulted in many highly successful research programmes.

View of La Silla from the 3.6-m telescope.

The VLT is a most unusual telescope, based on the latest technology. It is not just one, but an array of 4 telescopes, each with a main mirror of 8.2-m diameter. With one such telescope, images of celestial objects as faint as magnitude 30 have been obtained in a one-hour exposure. This corresponds to seeing objects that are 4 billion times fainter than what can be seen with the naked eye.

The VLT with stations of the VLTI (foreground).

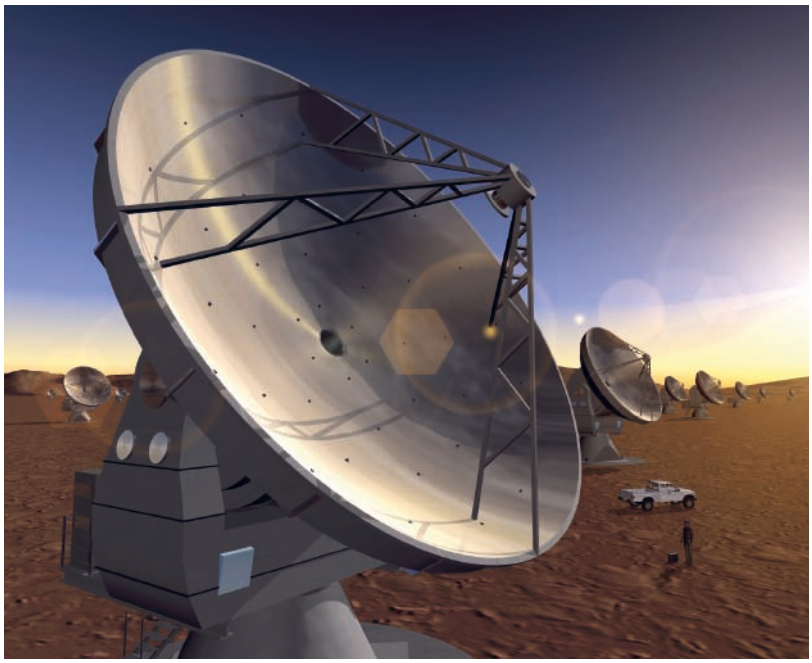
One of the most exciting features of the VLT is the possibility to use it as a giant optical interferometer (VLT Interferometer or VLTI). This is done by combining the light from several of the telescopes, including one or more of four 1.8-m moveable Auxiliary Telescopes, two of which have successfully passed their first tests in January 2004 and February 2005. In the interferometric mode, one can reach the resolution on the sky that would be obtained with a telescope of the size of the separation between the most distant of the combined mirrors.

Over 1500 proposals are made each year for the use of ESO telescopes. They have resulted in a large number of peer-reviewed publications. In 2004, more than 600 refereed papers were published based on data from ESO telescopes.

The Atacama Large Millimetre Array (ALMA), one of the largest ground-based astronomy projects of the next decade, is a major new facility for world astronomy. ALMA will be comprised of a giant array of 12-m submillimetre quality antennas, with baselines of several kilometres. Construction of ALMA started in 2003 and will be completed in 2012; it will become incrementally operational from 2010 on. ALMA is located on the high-altitude Llano de Chajnantor (5 000 m elevation), east of the village of San Pedro de Atacama in Chile. The ALMA project is a joint European/North American project; in Europe, ESO is leading on behalf of its eleven member countries and Spain. Japan is negotiating to join ALMA as a full partner.

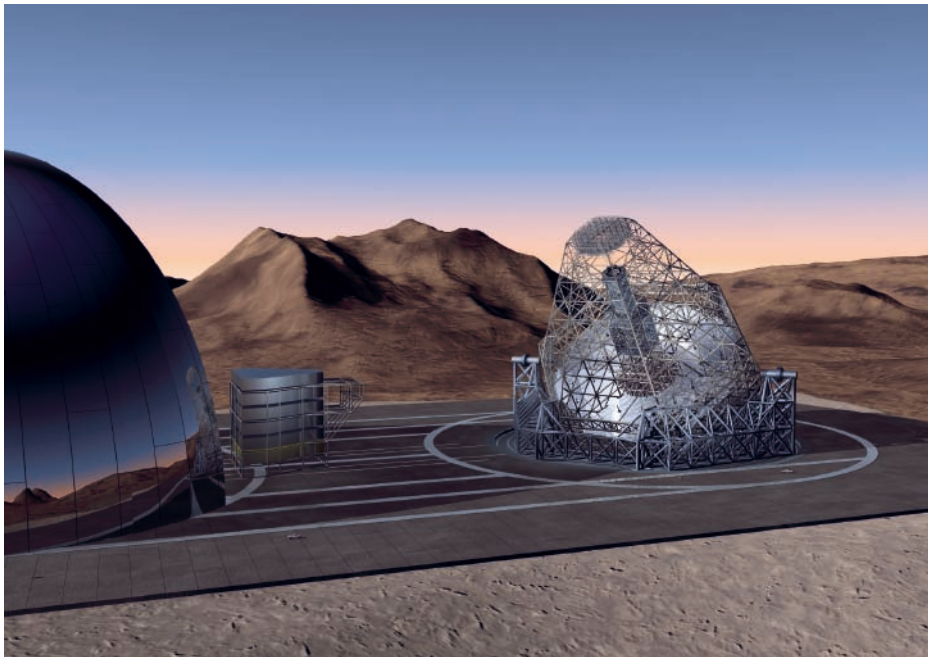
ESO is also proceeding with design studies for a 100-m-class, ground-based optical/infrared telescope: OWL. With a telescope of this size, it will be possible, by direct imaging, to discover possible Earth-like planets around other stars and to characterise them by spectroscopy of their atmospheres.

Artist's image of the Atacama Large Millimeter Array (ALMA).



The ESO headquarters are located in Garching, near Munich, Germany. This is the scientific, technical and administrative centre of ESO where technical development programmes are carried out to provide the observatories with the most advanced instruments. ESO employs about 650 staff members in Europe and Chile.

Artist's impression of ESO's OWL concept.



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Foreword

There is a well-known quote (I get more than 70 hits when I google it on the Web): "To do great and important tasks, two things are necessary: A plan and not quite enough time". As far as I am aware the origin of this quote is unknown.

In 2004 Finland has formally joined the organisation and has quickly developed into a fully integrated member of the community. We will commemorate this in June 2005, when Council will hold its regular meeting in Helsinki. During the year negotiations have started with Spain for formal accession to ESO; Spain is already participating in ALMA but both sides have expressed that extending this to cover other activities is a productive and desirable way forward.

In a significant move a working group of Council under the able chairmanship of the vice-president proposed a new manner of treating financial issues. This WG on "weighted voting" proposed a scheme to apply in the Finance Committee (FC) that – together with the assumption that Council would normally follow the advice of the FC – established a satisfactory modus operandi for the era of a probably increasing number of member states.

The Paranal Observatory is continuing to produce exciting results. Of the many remarkable findings I mention the mapping of the environment of a black hole in the centre of the active (Seyfert) galaxy NGC 1068 with the MIDI instrument on the VLTI, and the accurate dating of the stars in the globular cluster NGC 6397 and determination of the age of our Milky Way Galaxy. New instruments like SINFONI and AMBER and the start of the arrival and commissioning of the Auxiliary Telescopes for the VLTI were major milestones at Paranal, while the HARPS instrument at La Silla discovered the smallest extra-solar planet ever. A look through the 2004 press releases shows the enormous success of the Paranal Observatory. The increase in the number of papers published in the international refereed literature emphasizes the leading role of the installation.

ESO also played a major part in the outreach associated with the transit of Venus across the image of the solar disc. Council was in a premier position to judge the excellent work of the ESO staff as it was holding its June meeting in Garching during this phenomenon.

ALMA had significant progress and required much attention and hard work. If the quote at the start of this foreword has one application it certainly is ALMA. In spite of this the expected finalisation of the contracts for the antennas had to be delayed, first to December, but then to 2005. The careful analysis of the prototype antennas at the site of the VLA in Socorro in the USA did not result in time to sufficient certainty in the performance of the designs to place the contract with the required confidence, prudence and care. Yet, the project is moving forward with the hiring of two more key-personel in the Joint ALMA Office and activities in Chile on the infrastructure and ongoing work in various laboratories around the world on numerous aspects of the construction. The negotiations with Japan resulted in an agreement that spells out the general contents of the very important enhancement of ALMA. We very much welcome our Japanese colleagues as we move towards an integrated observatory with 6 or 7 frequency bands and an additional array for short-baseline and total power measurements, which will enormously increase the potential of ALMA.

At the end of the year, in its December meeting, Council unanimously approved a resolution that spells out in detail the scientific strategy of the organisation. In this resolution participation in an "Extremely Large Telescope" (of which the OWL concept is one of the possible ones) with a leading role for ESO, but where possible in intercontinental collaboration, is now the next priority of ESO after VLT, VLTI and ALMA. The fact that this resolution, based on extensive discussion in the special working group that prepared the report on which it was based and in Council itself, was adopted unanimously makes it a very significant resolve.

This will have to be translated still in a detailed plan of action. A first version of a revised "Long-Range Plan" (maybe redefined as Medium Range Plan, depending on the period to cover) was discussed in Council and these discussions will continue through 2005. Going back to the quote with which I started I state my belief that ESO is and will remain at the forefront and has a clear vision for the future. It should not have enough time, as we are eagerly looking forward to see new discoveries and enhance our understanding in our exciting science.

Piet van der Kruit
President of Council

Introduction

Another year has passed, full of excitement and important developments in and around ESO. In particular, we warmly welcomed Finland as the 11th ESO member state, with its scientific community that is renowned for their expertise in many frontline areas. The related opportunities will contribute to the strengthening of pioneering research with the powerful facilities at our observatories and we also look forward to collaborating with the Finnish high-tech industry.

It is obvious that ESO, with its many diverse activities and ever-improving observing facilities at the service of Europe's astronomers, is playing an increasingly central role in the current advances within the numerous branches of our wide science. Early in the year, we celebrated the fifth anniversary of astronomical observations with the VLT at Paranal. On April 1, 1999, the first 8.2-m VLT Unit Telescope, Antu (UT1), was "handed over" to the astronomers and ever since, science operations with this marvelous research tool have been continuous and intensive. Kueyen (UT2) started normal operations exactly one year later. Yepun (UT4) was offered to the scientific community in June 2001, while Melipal (UT3) followed in August 2001. Thanks to heroic and persistent efforts by the dedicated teams of ESO scientists and engineers, and with the truly excellent weather conditions at the Paranal site, over the first five years, an unbelievably high value of total time devoted to scientific observations has been reached (88 % on UTs with dark and bright time instruments), quite likely a new world record for ground-based 8–10 m class telescopes.

The outstanding success of this telescope, a true flagship in European research, is amply demonstrated by a fast-growing list of impressive scientific results, including quite a few fundamental discoveries that are now opening new horizons in astrophysics. The number of research papers based on VLT observations is increasing rapidly and is by now among the highest for ground-based astronomical observatories.

Exoplanets constitute one of the hottest fields in contemporary astrophysics and ESO has a powerful machinery in place for this. The ultra-precise HARPS spectrometer at the ESO 3.6-m telescope at La Silla is the undisputed leading "radial velocity machine" in the world; this was confirmed this year, among others, by the discovery of the lightest exoplanet found so far, just ~14 times more massive than the Earth. Not to be outdone, NACO at the VLT soon thereafter thrilled the world with what is almost certain to be the first photo ever of an exoplanet – subsequent astrometric observations corroborate this momentous break-through. Also of great significance was the discovery, based on VLTI MIDI observations, of chemical differences between the inner and outer sections of planet-forming discs around young stars. And we now look forward with great expectations to follow-up VLTI observations of known planetary systems, with the highest angular resolution available.

High-resolution images of Titan's atmosphere and surface were obtained with the Simultaneous Differential Imager (SDI) on NACO at the VLT, gaining useful information for the ESA Huygens probe before the landing on this mysterious satellite of Saturn. Another example of the wide range of observational programmes carried out at ESO's telescopes is provided by high-resolution UVES data of distant quasars which following very careful analysis provide the strongest astronomical constraints to date on the possible variation of the fine structure constant. Contrary to previous claims, they show no evidence for a time variation of this fundamental physical constant. Look in the science chapter of this Annual Report for more examples of great science!

Several new instruments were commissioned at ESO in 2004. Together with our partner institutes in Germany and The Netherlands, we celebrated the successful accomplishment of "First Light" for the

Adaptive Optics (AO) assisted SINFONI (Spectrograph for INtegral Field Observation in the Near-Infrared) instrument at the VLT. It is the first facility of this type ever installed on an 8-m class telescope, now providing exceptional observing capabilities for imaging and spectroscopic studies of very complex sky regions, e.g. stellar nurseries and black hole environments, also in distant galaxies. Its enormous potential has been well illustrated already, by unprecedented high-angular resolution spectra and images of stars in the immediate vicinity of the massive black hole at the centre of the Milky Way galaxy, including the detailed record of a flare from this enigmatic object.

Intriguing thermal infrared images of dust and gas heated by invisible stars in a distant region of our Milky Way marked the successful "First Light" of the VLT Imager and Spectrometer in the InfraRed (VISIR), developed by institutes in France and The Netherlands, with ESO support participation. With it, astronomers will from now on be able to perform very efficient imaging and spectral observations at mid-infrared wavelengths. Thanks to the high angular resolution possible with the VLT, VISIR will be a good complement to the ISO and Spitzer infrared space observatories. For instance, VISIR can take separate spectra of close binary brown dwarfs or young stars, which could not be separated by the Space observatories.

"First Fringes" was achieved for the Astronomical Multiple BEam Recombiner (AMBER), in another vital step towards full operation of the VLT Interferometer. Early in the year, a team of astronomers and engineers from ESO and its partner institutes in France, Italy, and Germany successfully completed the assembly and the first on-line tests of this first-generation VLTI near infrared instrument, combining the two beams of light from two small test telescopes to produce strong and clear interferometric fringes. Later, fringes were also obtained with the light beams from two, and even more exciting, three 8.2-m telescopes.

The first 1.8-m Auxiliary Telescope (AT1) is in place and is ready to be used. The second (AT2) arrived at Paranal at the end of the year and will become available in early 2005. Regular interferometric observations will then begin that no longer depend on the availability of the 8.2-m telescopes.

In Garching, "Laboratory First Light" was obtained for the VLT High-Resolution IR Echelle Spectrometer (CRIRES). The full system tests start in early 2005.

HAWK-I, the new VLT near infrared imager made good progress and passed its Final Design Review just before the end of the year.

Progress was also reported for the two survey telescopes to be installed at Paranal. The 16 k x 16 k OmegaCam detector system for the VLT Survey Telescope (VST) was assembled in Garching and first light in the laboratory was achieved with its 32 science-grade CCDs. The first integration of the telescope was done in Naples (Italy) and the VST enclosure is ready at Paranal. The VISTA telescope project, a survey telescope for the infrared, continued according to plan, including on-site work at Paranal and delivery by ESO Garching of the IRACE infrared detector controller, the largest ever built.

Work continued towards the realization of several second-generation VLT instruments. An ESO led consortium with institutes in Denmark, Italy, France and The Netherlands completed the preliminary design and passed the formal PDR Review of the X-shooter, a single-target Cassegrain spectrograph, covering the spectral range from the UV to the near-infrared in one exposure. It is designed to maximize the sensitivity in this vast spectral range and operates at intermediate resolution, sufficient to address quantitatively a vast number of astrophysical applications. The name of the instrument is inspired by the possibility to observe, in a single shot, faint sources at the sky limit with an unknown flux distribution.

Preliminary design studies of KMOS were continued by a UK-German consortium with support from ESO. This instrument is fully cryogenic and will provide the capability of providing integral field spectroscopy on up to 24 targets simultaneously in the infrared *J*-, *H*- or *K*-bands.

Studies continued of the Multi Unit Spectroscopic Explorer (MUSE) by a consortium comprising institutes in France, Germany, Switzerland, The Netherlands and the United Kingdom as well as ESO. It is a panoramic integral-field spectrograph operating in the visible wavelength range, which combines a wide field-of-view with improved spatial resolution (by adaptive optics) and a large simultaneous spectral range. It is optimised for the study of the progenitors of normal nearby galaxies at very high redshifts, but will also allow very detailed studies of nearby normal, starburst and interacting galaxies, and of galactic star formation regions.

At the Atacama Pathfinder Experiment (APEX), already in place at Chajnantor, surface setting was done (to 20 microns, an excellent value) and "First Light" achieved. APEX is now undergoing extensive commissioning and will be offered to the scientists in 2005. Nearly all local and international staff was hired.

The ALMA programme progressed in several directions. The Joint ALMA Office (JAO), comprising now ALMA Director, Manager and Project Engineer and associated staff, opened its offices in Santiago towards the end of the year. The Operations Support Facility (OSF) was further

expanded at the desert site between the cities of Toconao and San Pedro de Atacama, at 2 900 metres altitude. The temporary Agreement with Japan was signed by all partners. The interest for ALMA is rapidly growing, also among scientists at European institutes where submillimetre observations have little tradition, as seen, e.g., at the highly successful ALMA Community Day held in Garching.

Testing of the AEC prototype antenna continued at the VLA site at Socorro, and provisional acceptance was granted in December. Prototypes of all ALMA subsystems are now available. It was decided to implement changes to the Correlator as a step towards second-generation – a tunable filter bank is now under development at the University of Bordeaux (France).

The work of the project definition for an extremely large optical/infrared ground-based telescope continued at undiminished pace throughout the year. We were pleased that the proposed ELT Design Study was selected by the European Commission for support – it now involves 30 partners with ESO at the helm and covers a four-year period (2005–2008). Meanwhile, many aspects of the OWL Concept Study at ESO have progressed, including structural and safety analysis, wind measurements, studies of SiC blanks as well as the polishing. A study of the Control System for the main axis was completed and realistic simulations of the complex adaptive optics system continued. Conceptual studies on the OWL instruments are being launched in the community.

Steps were made to implement the planned merger of the La Silla and Paranal Observatories by February 1, 2005. This move will help to better manage ESO's many and diverse projects by deploying available resources more efficiently where and when they are needed. The merged observatory will be known as the "La Silla Paranal Observatory".

On December 9–10, ESO was honoured by the visit to the Paranal Observatory by His Excellency the President of the Republic of Chile, Ricardo Lagos and his wife, Mrs. Luisa Duran de Lagos, with the Chilean astronomer Maria Teresa Ruiz. The visit was characterised as private, and the President spent a considerable time in pleasant company with the observatory staff, and later participated in the evening's observations from the VLT Control Room.

A rare astronomy event happened on June 8, when Venus passed in front of the Sun, the first time since 1882. Already in 2002, ESO began to organize a major, related public education programme (VT-2004). It was successfully carried out in collaboration with scientific institutes, amateur associations, planetaria and other parties in over 30 European countries, and with substantial support by the European Commission. Tens of millions of people experienced this rare view with their own eyes, on television or on the web. Nearly 3 000 groups of lay observers, including almost 1 000 schools, joined the VT-2004 Observing Campaign and, following in the footsteps of past generations of astronomers, accurately determined the distance to the Sun.

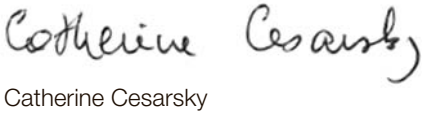
This was the year in which ESO optimized all of its administrative processes, and started using the new ESO Enterprise Resource Planning system. The Human Resource Module, including the payroll system for international and local staff, started operations in January and ran without major problems throughout the year 2004. Early June on, the Finance, Procurement and Logistic modules were also opened to all ESO users and in August the travel module followed. ESO ERP system is a fully integrated central system, which ESO users can access from all ESO sites and offices. The 2004 financial year end closing will be done for the first time with the new system. After this very important task the remaining functionalities of the systems and improved reporting features will be successively opened for use during 2005. We are very happy that we managed a smooth start of operations without major obstacles.

The ESO Visiting Committee delivered their report to Council who received it well. It presents a most useful overview and evaluation of ESO's current set-up and operations and confirms ESO's front-line position in the field of astronomy and astrophysics. It leaves the organisation and its Council with a very useful set of guidelines towards further improvements. The Visiting Committee also stressed the lack of space we are facing in our headquarters building in Garching and cautioned that it could be a limitation to possible ESO undertakings and, if worsened, might even become an issue for safety in the laboratories. The Visiting Committee considered therefore that the provision of significantly more space for ESO-Garching must be elevated to highest priority.

The ESO Council, considering during its December meeting the report of its Working Group for Scientific Strategic Planning, passed a wide-ranging resolution on ESO's future and its role in European astronomy (reproduced next page). I welcome the definition of ESO's goal as European retention of astronomical leadership and excellence into the era of Extremely Large Telescopes by carefully balancing the investment in its most important programmes and projects, completing a superb ALMA and maintaining the VLT leadership for at least ten years. The development of enabling technologies and the exploration of all options, including seeking additional funds, for fast implementation of an ELT are also advocated, to the satisfaction of the very motivated ESO staff.

We have indeed wonderful perspectives ahead of us.

Let us do it!



Catherine Cesarsky
Director General, ESO

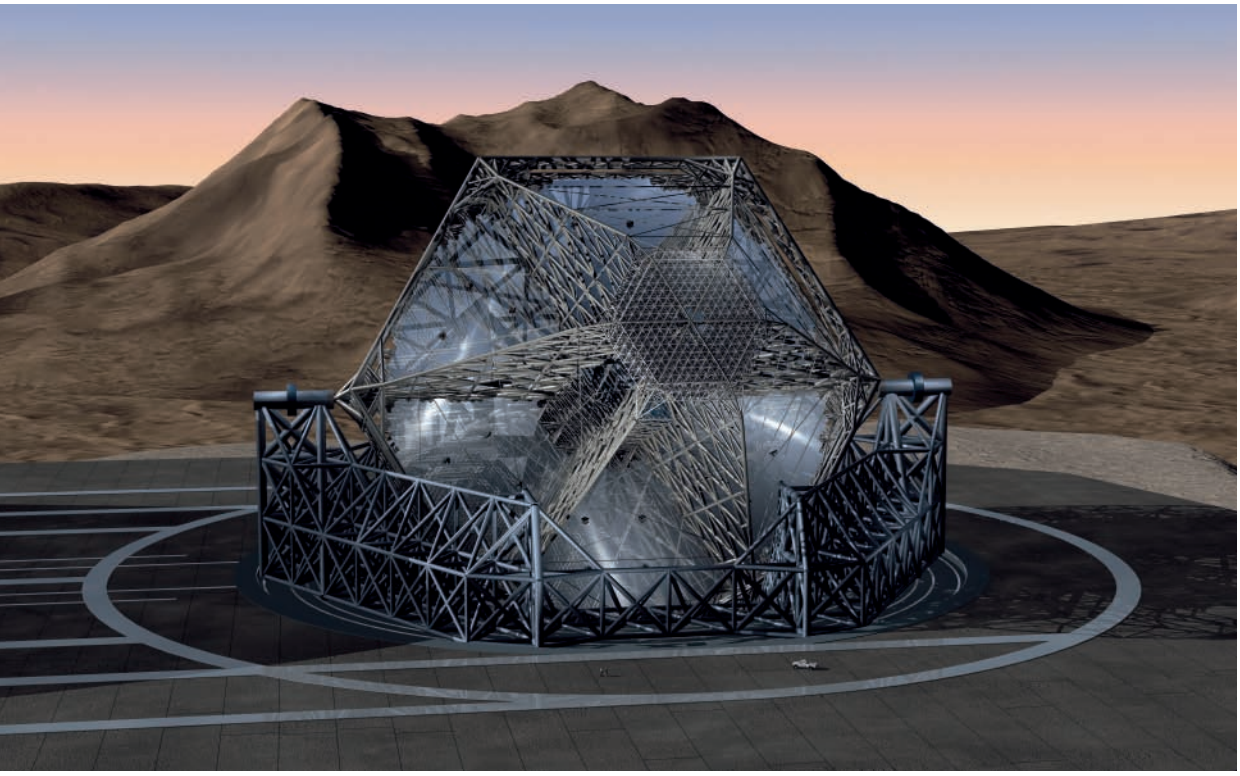
ESO Council Resolution on Scientific Strategy

ESO Council, considering the report of its Working Group for Scientific Strategic Planning, ESO/Cou-990, and its recommendations in ESO/Cou-964 rev. 2, agrees that

- astronomy is in a golden age with new technologies and telescopes enabling an impressive series of fundamental discoveries in physics (e.g. dark matter, dark energy, supermassive black holes, extrasolar planets),
- over the last decade, the continued investment of ESO and its community into the improvement of ground-based astronomical facilities has finally allowed Europe to reach international competitiveness and leadership in ground-based astronomical research,
- the prime goal of ESO is to secure this status by developing powerful facilities in order to enable important scientific discoveries in the future,
- only the continued investment in cutting edge technologies, telescopes, instruments and information technology will enable such scientific leadership and discoveries,
- ESO will continue to be open to new members and collaborations, following the principle of furthering scientific excellence,

and accordingly adopts the following principles for its scientific strategy:

- ESO's highest priority strategic goal must be the European retention of astronomical leadership and excellence into the era of Extremely Large Telescopes by carefully balancing its investment in its most important programmes and projects,
- the completion of ALMA is assured and conditions for an efficient exploitation of its superb scientific capabilities will be established,
- the VLT will continue to receive effective operational support, regular upgrading (especially to keep it at the forefront in image quality through novel adaptive optics concepts) and efficient second-generation instrumentation in order to maintain its world-leading position for at least ten more years,
- the unique capabilities of the VLTI will be exploited,
- the construction of an Extremely Large Telescope on a competitive time scale will be addressed by radical strategic planning, especially with respect to the development of enabling technologies and the exploration of all options, including seeking additional funds, for fast implementation,
- ESO and its community will continue their successful partnership and seek effective intercontinental collaborations in developing the most important and challenging technologies and facilities of the future.



OWL as shown in this artist's view, is one possible concept for an Extremely Large Telescope.

Research Highlights

This year has again confirmed the continuing trend of increase in the number of publications: La Silla and Paranal provided data for the publication of over 600 peer-reviewed journal articles, more than any other ground-based observatory. The two observatories had an equal share of papers while 39 papers are based in part or in full on data from the ESO archive. Fifteen refereed publications were based on data from the VLT Interferometer.

The ESO telescopes provided a real research bonanza of outstanding scientific results, some of which have been true breakthroughs. In particular, ESO has confirmed that with HARPS on the 3.6-m, NACO and FLAMES/UVES on the VLT and the VLTI, it possesses a very efficient set up for the study of exoplanets. This was verified by the discovery of the lightest exoplanet found so far, just about 14 times more massive than the Earth, and by what is most certainly the first photo ever of an exoplanet. The FLAMES/UVES facility allowed the mass of two hot transiting exoplanets to be determined, while MIDI on the VLTI provided the first proofs of chemical differences between the inner and outer parts of planet-forming discs around young stars.

Science with ESO telescopes covers other domains as well, from studies of objects in the Solar System to extra-galactic and cosmological research. New instrument facilities led to amazing scientific advances. In particular, the newly installed Simultaneous Differential Imager (SDI) on NACO at the VLT, provided the highest-resolution images of Titan's atmosphere and surface from the ground. The marvelous capabilities of the NACO imaging system were also demonstrated in a series of five papers published in April in the research journal Astronomy & Astrophysics.

Other results deal with the study of the Virgo cluster of galaxies through the analysis of intergalactic planetary nebulae or the peering inside of the active galactic nucleus, NGC 1068. Finally, the VLT can also be used as a very efficient tool for fundamental physics. Several analyses with UVES have indeed shown that the fine structure constant had the same value in the early universe as it has today.

The ESO telescope bibliography

The ESO telescope bibliography started out in the late seventies as a compilation of papers authored by visiting astronomers at the ESO telescopes in Chile, and ESO staff. These lists, published in the ESO Annual Report, provide today the only record of papers based on ESO observations arising from those early years. In the early nineties, ESO began to register bibliographic information of relevant papers in a database which is now maintained by the library. Later, the focus shifted from bibliographic details to observing facilities. Since 1996, the telescope information from all papers based on data from ESO La Silla is catalogued. Instrument information has been added to La Silla papers since 2002 and to papers using VLT data from First Light onwards. Furthermore, all VLT-based papers reference the programmes from which the data originated through programme identification codes (programme IDs), the unique identifiers of ESO observing proposals. Programme IDs are the vital link between archive and pre-observing (proposal and phase II) information and are a key component in joining the various ESO databases in preparation for the Virtual Observatory. As of July 2004, public access to the database became available through a web interface, located at *http://www.eso.org/libraries/telbib.html*. This is the result of a collaboration between the ESO library staff and the DMD/DFO Database Content Management team within the ESO Archive. The telescope bibliography is linked to the ESO observing programme and scheduling interface of the ESO/ST-ECF Science Archive Facility.
As of October 2004, abstracts of proposals are made available once the proprietary period of the associated data has expired. In addition, links to raw and possibly reduced data as well as to other publications related to the same programme are provided.
The reverse link has also been implemented. Starting at the ESO observation schedule query form at *http://archive.eso.org/wdb/wdb/eso/sched_rep_arc/form*, observing programme information can be retrieved by various qualifiers. From the results pages, users can reach the list of publications associated with a given VLT programme ID.

Fourteen times the Earth

Since the first detection in 1995 of a planet around the star 51 Peg, astronomers have learned that our Solar System is not unique, as more than 150 giant planets orbiting other stars have been discovered mostly by radial-velocity surveys. This fundamental observational method is based on the detection of variations in the velocity of the central star, due to the changing direction of the gravitational pull from an (unseen) exoplanet as it orbits the star. The evaluation of the measured velocity variations allows astronomers to deduce the planet's orbit, in particular the period and the distance from the star, as well as a minimum mass.

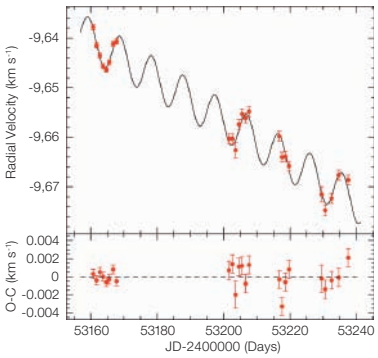
The continued quest for exoplanets requires better and better instrumentation. In this context, ESO undoubtedly assumed the leadership with the new HARPS spectrograph (High Accuracy Radial Velocity Planet Searcher) at the 3.6-m telescope at the La Silla Observatory. Offered since October 2003 to the users' community, this unique instrument is optimized to detect exoplanets by means of accurate radial velocity measurements with an unequalled precision of 1 metre per second. These improvements have opened new perspectives in the search for extra-solar planets and have set new standards in terms of instrumental precision. The new results on the star mu Arae have set a record for the discovery of the lightest exoplanet ever observed.

The star mu Arae is a solar-like star bright enough (5th magnitude) to be observed with the unaided eye. Mu Arae was already known to harbour a Jupiter-sized planet with a 650 days orbital period. Previous observations also hinted at the presence of another companion (a planet or a star) much further away. The new measurements confirm this picture, but also showed that an additional planet in short orbit is present.

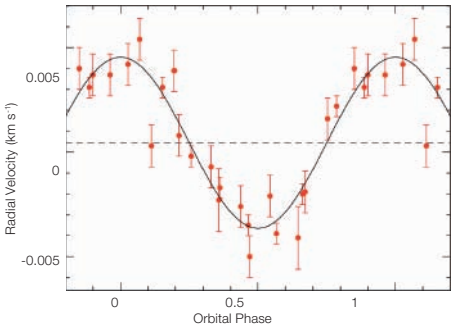
During eight nights in June 2004, mu Arae was repeatedly observed and its radial velocity measured by HARPS to obtain information on the interior of the star. This so-called astero-seismology technique studies the small acoustic waves that make the surface of the star periodically pulsate in and out. By knowing the internal structure of the star, the astronomers aimed at understanding the origin of the unusual amount of heavy elements observed in its stellar atmosphere. This unusual chemical composition could provide unique information on the history of planetary formation.

The analysis of the new measurements revealed a radial velocity variation with a period of 9.5 days on top of the acoustic oscillation signal. Additional data, taken as part of the HARPS consortium survey programme, confirmed both the amplitude and the periodicity of the radial velocity variations. A second (or third if the further-away-companion turns out to be a planet as well) planet thus orbits mu Arae and accomplishes a full revolution in 9.5 days. Moreover, the radial velocity amplitude implies a mass for the planet of only 14 times the mass of the Earth! This is about the mass of Uranus, the smallest of the giant planets in the solar system. The newly found exoplanet therefore sets a new record in the smallest planet discovered around another star.

The mass of this planet places it at the boundary between the very large earth-like (rocky) planets and giant planets. As current planetary formation models are still far from being able to account for all the amazing diversity observed amongst the extrasolar planets discovered, one can only speculate on the true nature of the present object. In the current paradigm of giant planet formation, a core is formed first through the accretion of solid "planetesimals". Once this core reaches a critical mass, gas accumulates in a "runaway" fashion and the mass of the planet increases rapidly. In the present case, this later phase is unlikely to have happened for otherwise the planet would have become much more massive. Furthermore, with recent models having shown that migration shortens the formation time, it is unlikely that the present object has migrated over large distances and remained of such small mass. This object is therefore likely to be a planet with a rocky (not an icy) core surrounded by a small (of the order of a tenth of the total mass) gaseous envelope and would therefore qualify as a "Super-Earth".



Radial velocity measurements of mu Arae obtained with HARPS.



HARPS radial velocity measurements phase-folded with the orbital period of the newly found exoplanet (9.5 days).

The detection of this new light planet after less than one year of operation demonstrates the outstanding potential of HARPS for detecting rocky planets. Further analysis shows that performance achieved with HARPS possibly allow for the detection of big "telluric" planets with only a few times the mass of the Earth. Such a capability is a major improvement compared to past planet surveys. Detection of such rocky objects strengthens the interest in future transit detections.

Two extremely hot transiting exoplanets

The radial-velocity technique is not the only tool for the detection of exoplanets. When a planet happens to pass in front of its parent star (as seen from the Earth), it blocks a small fraction of the star's light from our view. This can be detected by means of stellar photometric measurements and several surveys are presently underway worldwide.

One of these, the Optical Gravitational Lensing Experiment (OGLE) survey, was originally devised to detect microlensing events by monitoring the brightness of a very large number of stars at regular intervals. For the past four years, it has also included a search for periodical shallow "dips" of the brightness of stars, caused by the regular transit of small orbiting objects (small stars, brown dwarfs or Jupiter-size planets). The OGLE team has since announced 137 "planetary transit candidates" from their survey of about 155 000 stars in two southern sky fields, one in the direction of the Galactic Centre, the other within the constellation of Carina.

The presence of a transit event alone, however, does not reveal the nature of the transiting body. This is because a low-mass star or a brown dwarf, as well as the variable brightness of a background eclipsing binary system seen in the same direction, may result in brightness variations that simulate the ones produced by an orbiting giant planet.

However, the nature of the transiting object may be established by radial-velocity observations of the parent star. The size of the velocity variations (the amplitude) are directly related to the mass of the companion object and therefore allow discrimination between stars and planets as the cause of the observed brightness "dip".

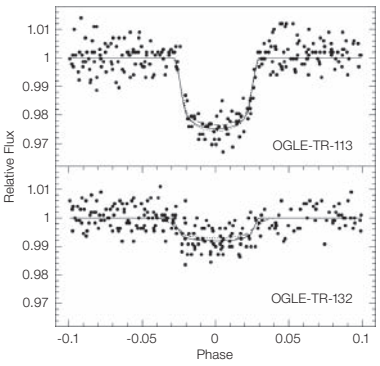
The FLAMES/UVES instrument on the 8.2-m VLT Kueyen telescope was used to perform such a radial-velocity follow-up. In March 2004, 41 OGLE "top transit candidate stars" were followed during eight half-nights. The multiplex capacity of the FLAMES/UVES fibre link facility enables high-resolution spectra of eight objects to be obtained simultaneously and measures stellar velocities with an accuracy of about 50 m/s.

While the vast majority of OGLE transit candidates turned out to be binary stars (mostly small, cool stars transiting in front of solar-type stars), two of the objects, designated as OGLE-TR-113 and OGLE-TR-132, were found to exhibit small velocity variations, indicating Jupiter-like masses.

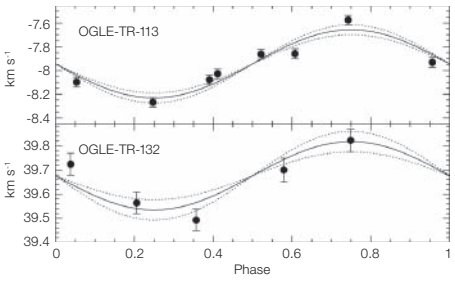
Interestingly, both new planets were detected around rather remote stars in the Milky Way galaxy, in the direction of the southern constellation Carina. For OGLE-TR-113, the parent star is of F-type (slightly hotter and more massive than the Sun) and is located at a distance of about 6000 light-years. The orbiting planet is about 35 % heavier and its diameter is 10 % larger than that of Jupiter, the largest planet in the solar system. It orbits the star once every 1.43 days at a distance of only 3.4 million km (0.0228 AU). The surface temperature of the planet, which like Jupiter is a gaseous giant, is correspondingly higher, probably above 1800 °C.

The distance to the OGLE-TR-132 system is about 1200 light-years. This planet is about as heavy as Jupiter and about 15 % larger (its size is still somewhat uncertain). It orbits a K-dwarf star (cooler and less massive than the Sun) once every 1.69 days at a distance of 4.6 million km (0.0306 AU). Also this planet must be very hot.

With the previously found planetary transit object OGLE-TR-56, the two new OGLE objects define a new class of exoplanets: planets with extremely short periods and correspondingly small orbits. The existence of the three OGLE planets now shows that "very hot Jupiters" do exist, even though they may be quite rare; probably about one such object for every 2500 to 7000 stars.

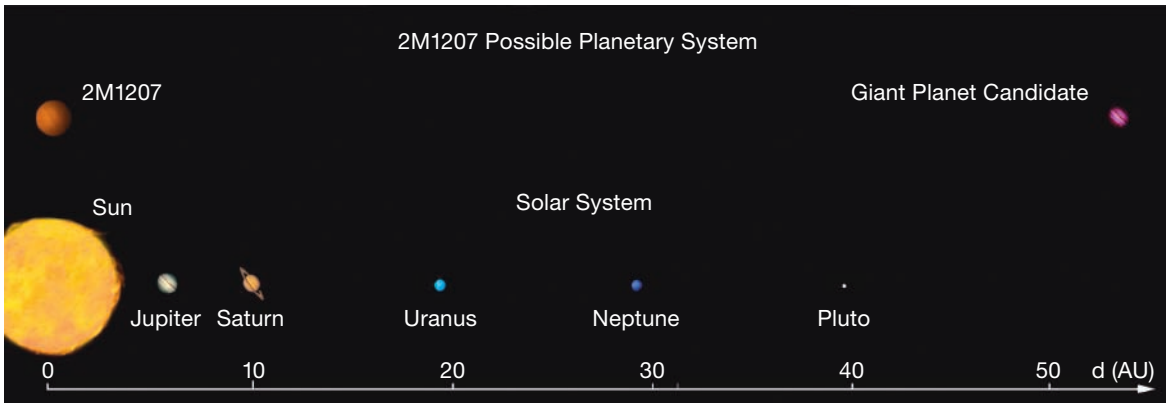


Brightness "dips" of the stars OGLE-TR-113 (upper) and OGLE-TR-132 (lower), as observed during the OGLE survey.



Velocity variations of OGLE-TR-113 and OGLE-TR-132 from FLAMES/VLT observations.

The first image of an extrasolar planet?



Comparison between the solar and 2M1207 systems.

Instead of detecting exoplanets by indirect methods, such as radial velocity surveys or observations of a transit, it would be preferable to obtain a direct image permitting the characterization of a planet in its own light. This is however an exceedingly difficult task, as the planet is generally hidden in the "glare" of its host star.

A way to partly overcome this problem is to study very young stars. Indeed, sub-stellar objects are much hotter and brighter when young – tens of millions of years – and can therefore be more easily detected than older objects of similar mass.

Stars in the TW Hydrae Association are about eight million years old and are located in the direction of the constellation Hydra (The Water-Snake), at a distance of about 230 light-years. Observations of a few selected stars in this region were done with the NAOS-CONICA (NACO) facility on the VLT as part of a dedicated programme of finding sub-stellar companions to young objects. The instrument's adaptive optics (AO) overcomes the distortion induced by atmospheric turbulence, producing extremely sharp near-infrared images. Indeed the infrared wavefront sensor was an essential component of the AO system for the success of these observations. This unique instrument senses the deformation of the near-infrared image, i.e. in a wavelength region where young low-mass objects are much brighter than in the visible range.

On a series of exposures made through different optical filters of the brown-dwarf object 2MASSWJ1207334-393254 in the TW Hydrae Association, or just "2M1207", a tiny red speck of light, only 0.8 arcsec away, was discovered. The feeble image is more than 100 times fainter than that of 2M1207.

Additional spectroscopy with NACO has confirmed the sub-stellar sta-tus of this object by identifying broad water-band absorptions in its atmosphere.

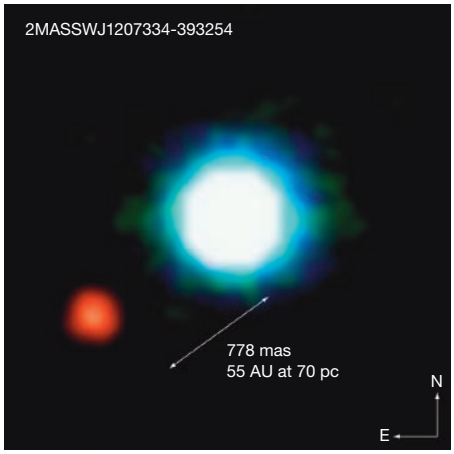
The brown dwarf 2M1207 has approximately 25 times the mass of Jupiter and is thus about 42 times lighter than the Sun. As a member of the TW Hydrae Association, it is about eight million years old.

Taking into account the infrared colours and the spectral data available for the companion, evolutionary model calculations point to a 5 Jupiter-mass planet, about 55 times more distant from 2M1207 than the Earth is from the Sun (55 AU). The surface temperature appears to be about 10 times hotter than Jupiter, about 1000 °C; this is easily explained by the amount of energy that must be liberated during the current rate of contraction of this young object (indeed, the much older giant planet Jupiter is still producing energy in its interior).

Over the next few years, repeated observations of the object should establish beyond doubt whether the object is indeed a planet in orbit around the brown dwarf 2M1207 by watching how the two objects move through space and to learn whether or not they move together.

Because our solar system is 4 600 million years old, there is no way to directly measure how the Earth and other planets formed during the first tens of millions of years following the formation of the Sun. But, if astronomers can study the vicinity of young stars that are now only tens of millions of years old, then by witnessing a variety of planetary systems that are now forming, they will be able to understand much more accurately our own distant origins.

If confirmed, this discovery thus represents a first step towards opening a whole new field in astrophysics: the imaging and spectroscopic study of planetary systems. Such studies will enable astronomers to characterize the physical structure and chemical composition of planets.



NACO composite image of the brown dwarf object 2M1207 and the Giant Planet Candidate Companion seen near it, at an angular distance of 778 milliarcsec.

Formation of rocky planets in circumstellar discs

The Sun was born about 4 500 million years ago from a cold and massive cloud of interstellar gas and dust that collapsed under its own gravitational pull. A dusty disc was present around the young star, in which the Earth and other planets, as well as comets and asteroids formed. This epoch is long gone, but we may still witness that same process by observing the infrared emission from very young stars and the dusty protoplanetary discs around them. So far, however, the available instrumentation has not allowed for a study of the distribution of the different components of the dust within such discs; even the closest known are too far away for the best single telescopes to resolve them.

Things have now improved with the advent of the VLT Interferometer (VLTI) and its ability to combine the light from two or more well-separated large telescopes to obtain unprecedented angular resolution. Using the VLTI, it has been possible, for the first time, to peer directly into the innermost region of the discs around some nearby young stars, right in the place where we expect planets like our Earth to form.

Specifically, new interferometric observations of three young stars, using the combined power of two 8.2-m VLT telescopes a hundred metres apart, has achieved sufficient image sharpness (about 0.02 arcsec) to measure the infrared emission from the inner region of the discs around three stars (corresponding approximately to the size of the Earth's orbit around the Sun) and the emission from the outer part of those discs. The corresponding infrared spectra have provided crucial information about the chemical composition of the dust in the discs and also about the average grain size.

These trailblazing observations show that the inner part of the discs is very rich in crystalline silicate grains ("sand") with an average diameter of about 1 micron. They are formed by coagulation of much smaller, amorphous dust grains that were omnipresent in the interstellar cloud that gave birth to the stars and their discs.

Model calculations show that crystalline grains should be abundantly present in the inner part of the disc at the time of formation of the Earth. In fact, the meteorites in our own solar system are mainly composed of this kind of silicate.

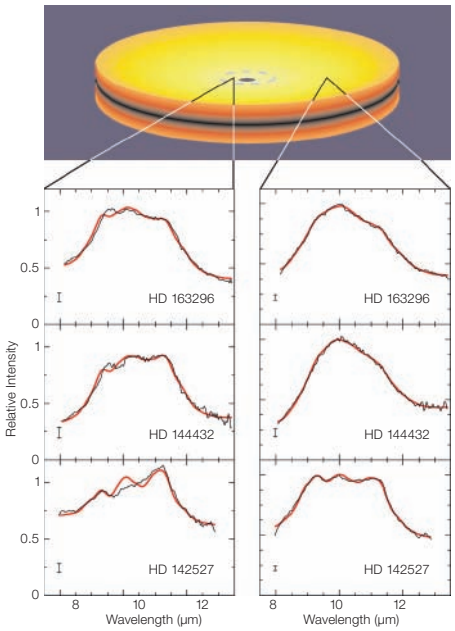
It has been known for some time that most of the dust in discs around newborn stars is made up of silicates. In the natal cloud this dust is amorphous, i.e. the atoms and molecules that make up a dust grain are put together in a chaotic way, and the grains are fluffy and very small, typically about 0.1 micron in size. However, near the young star where the temperature and density are highest, the dust particles in the circumstellar disc tend to stick together so that the grains become larger. Moreover, the dust is heated by stellar radiation and this causes the molecules in the grains to rearrange themselves in geometric (crystalline) patterns.

Accordingly, the dust in the disc regions that are closest to the star is soon transformed from "pristine" (small and amorphous) to "processed" (larger and crystalline) grains.

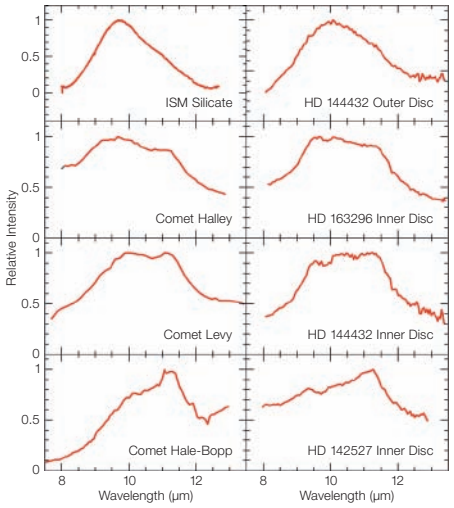
Spectral observations of silicate grains in the mid-infrared wavelength region (around 10 μm) can tell whether they are "pristine" or "processed". Earlier observations of discs around young stars have shown a mixture of pristine and processed material to be present, but it was so far impossible to tell where the different grains resided in the disc.

Thanks to a hundred-fold increase in angular resolution with the VLTI and the highly sensitive MIDI instrument, detailed infrared spectra of the various regions of the protoplanetary discs around three newborn stars, only a few million years old, now show that the dust close to the star is much more processed than the dust in the outer disc regions. In two stars (HD 144432 and HD 163296) the dust in the inner disc is fairly processed whereas the dust in the outer disc is nearly pristine. In the third star (HD 142527) the dust is processed in the entire disc. In the central region of this disc it is extremely processed, consistent with completely crystalline dust.

Mid-IR spectra of the inner and outer disc regions of three young stars.



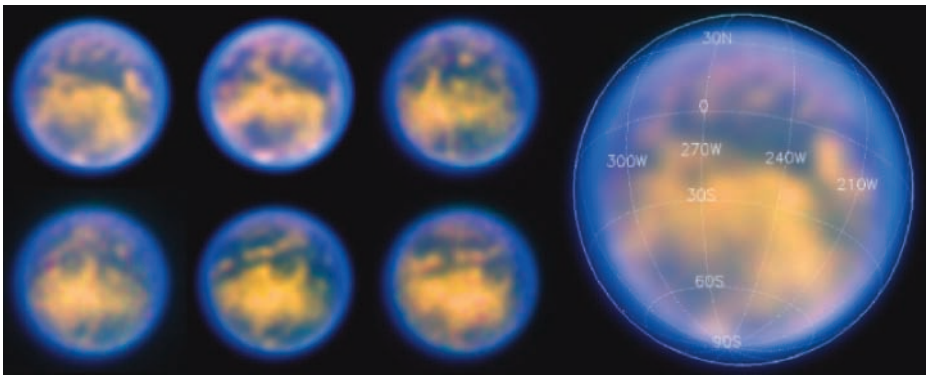
Comparison of mid-IR spectra of various astronomical objects with those of the inner and outer disc regions of three young stars.



An important conclusion from the VLTI observations is therefore that the building blocks for Earth-like planets are present in circumstellar discs from the very start. This is of great importance as it indicates that planets of the terrestrial (rocky) type like the Earth are most probably quite common in planetary systems, also outside the solar system.

Surface and atmosphere of Titan

Views of Titan, obtained on six nights in February 2004.

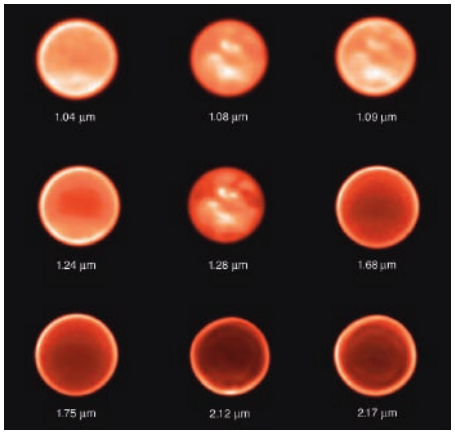


Titan, the largest moon of Saturn was discovered by Dutch astronomer Christian Huygens in 1655 and certainly deserves its name. With a diameter of no less than 5150 km, it is larger than Mercury and twice the size of Pluto. It is unique in having a hazy atmosphere of nitrogen, methane and oily hydrocarbons. Although it was explored in some detail by the NASA Voyager missions, many aspects of the atmosphere and surface still remain unknown. Thus, the existence of seasonal or diurnal phenomena, the presence of clouds, the surface composition and topography are still under debate.

Recent spectroscopic and radar observations suggest that there are huge surface reservoirs of liquid hydrocarbons and a methane-based meteorological cycle similar to Earth's hydrological cycle. This makes Titan the only known object with rainfall and potential surface oceans other than the Earth and thus a tantalizing research object for the study of pre-biotic chemistry and the origin of life on Earth.

The Huygens probe launched from the NASA/ESA Cassini-Huygens mission will enter Titan's atmosphere in early 2005 to perform measurements of the physical and chemical conditions.

Titan observed through nine different filters on November 26, 2002 probing different altitudes, ranging from the stratosphere to the surface.



Ground-based observations are essential to optimize the return of this space mission, because they will complement the information gained from space and add confidence to the interpretation of the data. Hence, the advent of the adaptive optics system NACO on the fourth 8.2-m VLT unit telescope, Yepun, offered a unique opportunity to study the resolved disc of Titan with high sensitivity and increased spatial resolution.

A first study obtained images through nine narrow-band filters, sampling near-infrared wavelengths with large variations in methane opacity. This permits sound-ing of different altitudes ranging from the stratosphere to the surface. These extraordinary images have a nominal resolution of 0.03 arcsec and show details of the order of 200 km on the surface of Titan. To provide the best possible views, the raw data from the instrument were subjected to deconvolution (image sharpening).

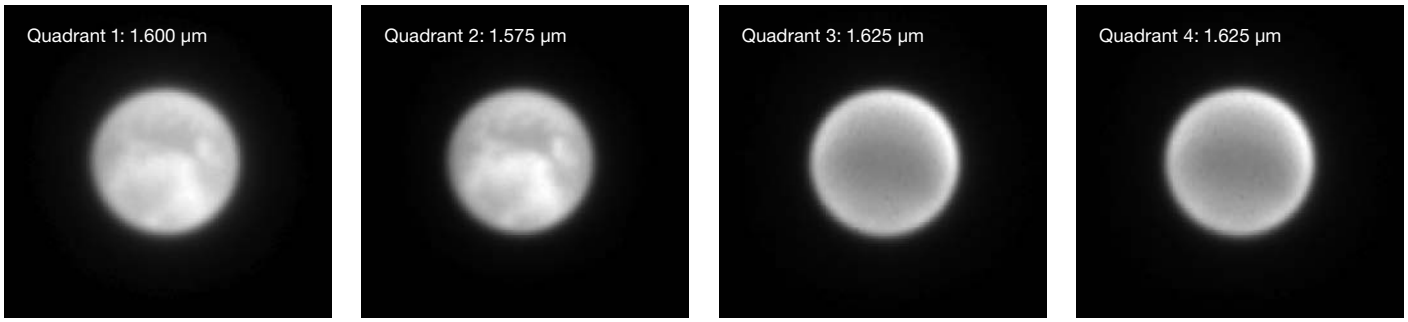
Titan harbours at 1.24 and 2.12 µm a "southern smile", that is, a north-south asymmetry, while the opposite situation is observed with filters probing higher altitudes, such as 1.64, 1.75 and 2.17 µm. A high-contrast bright feature is observed at the South Pole and is apparently caused by a phenomenon in the atmosphere, at an altitude below 140 km or so. This feature was found to change its location on the images from one side of the south polar axis to the other during the week of observations.

The wavelengths used for such observations are critical for the amount of surface detail captured on the images. Optimally, one would look for a spectral band in which the atmosphere is completely transparent. But although the above observations were made in wavebands roughly matching atmospheric windows and do show surface features, they also include the light from different atmospheric layers. In a sense, they therefore correspond to viewing Titan's surface through a somewhat opaque screen or, more poetically, the sight by an ancient sailor, catching for the first time a glimpse of an unknown continent through the coastal haze.

One narrow "window" is available in the near-infrared spectral region near wavelength 1.575 µm. In February 2004, images of Titan's surface were obtained through this spectral window with unprecedented spatial resolution and with the lowest contamination of atmospheric condensates to date.

This was accomplished during six nights (February 2, 3, 5, 6, 7 and 8, 2004) at the time of the commissioning phase of the Simultaneous Differential Imager (SDI), a novel high-contrast imaging mode for NACO. This optical device provides four simultaneous high-resolution images at three wavelengths around a near-infrared atmospheric methane absorption feature. The main application of the SDI is high-contrast imaging for the search for substellar companions with methane in their atmosphere, e.g. brown dwarfs and giant exoplanets, near other stars. However, it is also superbly suited for Titan imaging.

Four images of Titan, obtained simultaneously with the NACO adaptive optics instrument in the SDI observing mode.



To obtain unique images of the surface of Titan, the simultaneous "atmospheric" images (at waveband 1.625 µm) were "subtracted" from the "surface" images (1.575 and 1.600 µm) in order to remove any residual atmospheric features present in the latter.

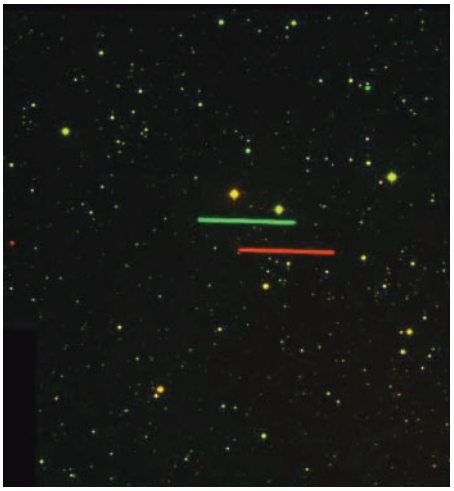
Titan is tidally locked to Saturn, and hence always presents the same face towards the planet. To image all sides of Titan (from the Earth) therefore requires observations during almost one entire orbital period, 16 days. Still, the present week-long observing campaign enabled the mapping of approximately three-quarters of the surface of Titan.

Over the range of longitudes which have been mapped during the present observations, it is obvious that the southern hemisphere of Titan is dominated by a single bright region centred at approximately 15° longitude. The equatorial area displays well-defined dark (low-reflection) structures.

The imaging and monitoring of Titan will continue, with the goal of assisting the Cassini-Huygens team in the interpretation and understanding of what will certainly be a rich and complex flow of information about this enigmatic moon.

The parallax of Asteroid Toutatis

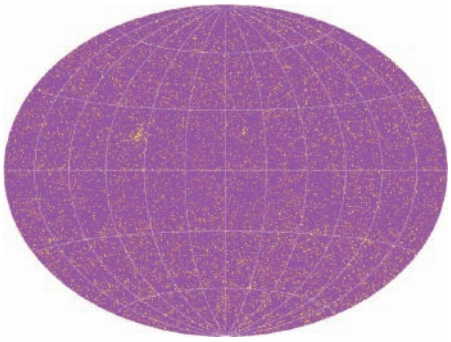
On September 29, 2004, the asteroid Toutatis approached the Earth to within 1550 000 km, or just four times the distance of the Moon. Simultaneous images obtained with telescopes at ESO's two observatories at La Silla and Paranal were taken just over 12 hours before the closest approach. They clearly demonstrate the closeness of Toutatis to the Earth. As can be seen on the unique photo that combines two of the exposures from the two observatories, the sighting angle to Toutatis from the two observatories, 513 km apart, is quite different.



The measured angular distance in the sky of the beginnings (or the ends) of the two trails (about 40 arcsec), together with the known distance between the two observatories and the position of Toutatis in the sky at the moment of the exposures fully define the triangle "Paranal-Toutatis-La Silla" and thus allow the calculation of the exact distance to the asteroid.

It is found to be very close to that predicted from the asteroid's position in its orbit and that of the Earth at the moment of this unique observation, 1607 900 km.

Milky Way past was more turbulent than previously known



Sky distribution of the approximately 14 000 observed stars.

Home is the place we know best. But not so in the Milky Way – the galaxy in which we live. Our knowledge of our nearest stellar neighbours has long been seriously incomplete and – worse – skewed by prejudice concerning their behaviour. Stars were generally selected for observation because they were thought to be "interesting" in some sense, not because they were typical. This has resulted in a biased view of the evolution of our Galaxy.

The Milky Way started out just after the Big Bang as one or more diffuse blobs of gas of almost pure hydrogen and helium. With time, it assembled into the flattened spiral galaxy which we inhabit today. Meanwhile, generation after generation of stars were formed, including our Sun some 4 500 million years ago.

But how did all this really happen? Was it a rapid process? Was it violent or calm? When were all the heavier elements formed? How did the Milky Way change its composition and shape with time? Answers to these and many other questions are 'hot' topics for those astronomers who study the birth and evolution of the Milky Way and other galaxies.

Rich results of a 15 year-long marathon survey are now providing some of the answers. More than 1000 observing nights over 15 years at the Danish 1.5-m telescope at La Silla and at the Swiss 1-m telescope of the Observatoire de Haute-Provence (France) were used in this study. Additional observations were made at the Harvard-Smithsonian Center for Astrophysics in the USA. A total of more than 14 000 solar-like stars (so-called F- and G-type stars) were ob-served at an average of four times each – a total of no less than 63 000 individual spectroscopic observations!

This now complete census of neighbourhood stars provides distances, ages, chemical analysis, space velocities and orbits in the general rotation of the Milky Way. It also identifies those stars (about 1/3 of them all) which the astronomers found to be double or multiple.

These observations effectively mark the conclusion of a project started more than twenty years ago. In fact, they constitute the fulfilment of an old dream by Danish astronomer Bengt Strömgren (1908–1987), who pioneered the study of the history of the Milky Way through systematic studies of its stars. Already in the 1950's he designed a special system of colour measurements to determine the chemical composition and ages of many stars very efficiently. And the Danish 50-cm and 1.5-m telescopes at the ESO La Silla Observatory were constructed to make such projects possible.

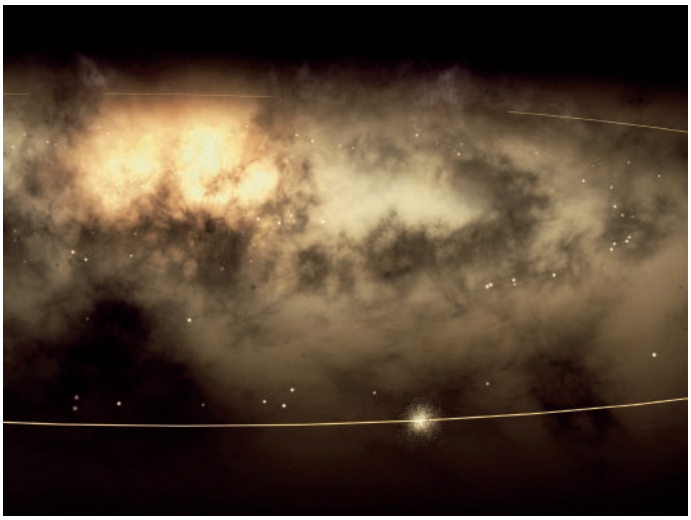
Another Danish astronomer, Erik Heyn Olsen made the first step in the 1980's by measuring the flux (light intensity) in several wavebands (in the "Strömgren photometric system") of 30 000 A, F and G stars over the whole sky to a fixed brightness limit. Next, ESA's Hipparcos satellite determined precise distances and velocities in the plane of the sky for these and many other stars.

The missing link was the motions along the line of sight (the so-called radial velocities). They were then measured during the present study from the Doppler shift of spectral lines of the stars (the same technique that is used to detect planets around other stars), using the specialized CORAVEL instrument.

With the velocity information completed, it is now possible to compute how the stars have wandered around in the Galaxy in the past, and where they will go in the future.

The initial analysis indicates that objects like molecular clouds, spiral arms, black holes, or maybe a central bar in the Galaxy, have stirred up the motion of the stars throughout the entire history of the Milky Way disc.

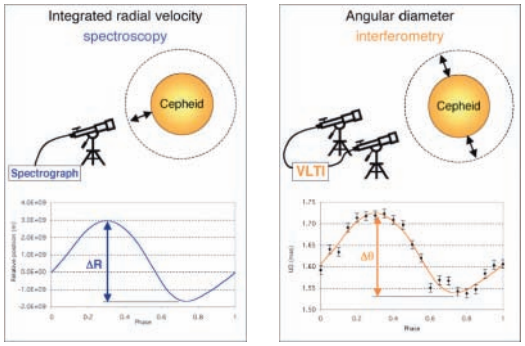
This in turn reveals that the evolution of the Milky Way was far more complex and chaotic than traditional, simplified models have long so far assumed. Supernova explosions, galaxy collisions, and infall of huge gas clouds have made the Milky Way a very lively place indeed!



Stars in the solar neighbourhood.

Calibrating the cosmic distance ladder

It is very difficult to measure the distance to an astronomical object. In fact, this is one of the greatest challenges facing astronomers. There is indeed no accurate, direct way to determine the distance to galaxies beyond the Milky Way: astronomers first determine the distance to nearby stars in our galaxy as accurately as possible and then use a series of other techniques that reach progressively further into space to estimate distances to more distant systems. This process is often referred as the "cosmic distance ladder".



The two observation techniques used for the interferometric version of the Baade-Wesselink method: high-resolution spectroscopy (left) and interferometry (right).

Over the years, a number of different distance estimators have been found. One of these is a particular class of stars known as Cepheid variables. They are used as one of the first "steps" on this cosmic distance ladder.

Cepheids are rare and very luminous stars whose luminosity varies in a very regular way. They follow a so-called "Period-Luminosity relation" (intrinsically brighter Cepheids have longer periods) which is an important way to derive the distance to stars of this type. By measuring the period of a Cepheid star, its intrinsic brightness can be deduced and from the observed apparent brightness, the distance may then be calculated. In this way, Cepheid stars are used by astronomers as one of the "standard candles" in the Universe.

The Cepheid stars have taken on an even more important role since they have become the major step from the Milky Way to nearby galaxies. The calibration of secondary distance indicators, e.g. galaxy relations, novae and supernovae, used to gauge cosmologically large distance relies completely on Cepheids. In other words, if the calibration of the Cepheid Period-Luminosity relation were wrong, the entire extragalactic distance scale and with it, the rate of cosmic expansion and the related acceleration, as well as the estimated age of the Universe, would also be wrong.

Independent determinations of the distance of variable stars make use of the "Baade-Wesselink" method. With this classical method, the variation of the angular diameter of a Cepheid variable star is inferred from the measured changes in brightness (by means of model atmosphere calculations) as it pulsates. Spectroscopy is then used to measure the corresponding radial velocity variations, hence providing the linear distance over which the star's outer layers have moved. By dividing the angular and linear measures, the distance to the star is obtained.

It would obviously be much better to measure the variation of the radius directly and not to rely on model atmosphere calculations. But here the main problem is that, despite their apparent brightness, all Cepheids are situated at large distances. Indeed, the closest Cepheid star (excluding the peculiar star Polaris), Delta Cephei, is more than 800 light-years away. Even the largest Cepheids in the sky subtend an angle of only 0.003 arcsec.

Some time ago, a major research programme was started, aimed at measuring the distance to several Cepheids by means of the above outlined Baade-Wesselink interferometric method. For these observations sets of two beams were combined: one set from the two VLTI Test Siderostats with 0.35m aperture and the other set from two Unit Telescopes (Antu and Melipal; 8.2-m mirrors) – with the VINCI (VLT Interferometer Commissioning Instrument) facility. Three VLTI baselines were used for this programme with, respectively, 66, 140 and 102.5 m ground length.

A total of 69 individual angular diameter measurements were obtained with the VLTI, over more than 100 hours of total telescope time, distributed over 68 nights; the largest angular diameter measured was 0.0032 arcsec (L Car at maximum).

Seven Cepheids observable from Paranal Observatory were selected for this programme: X and W Sagittarii, Eta Aquilae, Beta Doradus, Zeta Gemini, Y Ophiocus and L Carinae. Their periods range from seven to 35.5 days, a fairly wide interval and an important advantage to properly calibrate the Period-Luminosity relation.

The distances to four of the stars (Eta Aql, W Sgr, Beta Dor and L Car) were derived using the interferometric Baade-Wesselink method, as their pulsation is detected by the VLTI. For L Car (P = 35.5 days), its distance is determined with a relative precision better than 5 %.

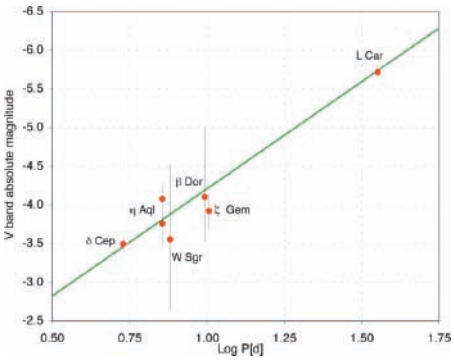
For the remaining three objects of the sample (X Sgr, Zeta Gem and Y Oph), a hybrid method was applied to derive their distances, based on their average angular diameter and pre-existing estimations of their linear diameters.

Combining the distances measured by this programme with the apparent magnitudes of the stars, the absolute magnitude (intrinsic brightness) of these stars was determined, leading to a very precise calibration of the zero-point of the Period-Luminosity relation (assuming the slope from previous work).

It turned out that this new and independently derived value of the zero-point is exactly the same as the one obtained during previous work based on a large number of relatively low-precision Cepheid distance measurements by the ESA Hipparcos astrometric satellite. The agreement between these two independent, geometrical calibrations is remarkable and greatly increases the confidence in the cosmic distance scale now in use.

With several 1.8-m Auxiliary Telescopes soon to be ready on the VLTI platform, astronomers will be able to observe many more Cepheids with a precision at least as good as the present high-precision VINCI observations of L Car. In addition, the future AMBER instrument will extend the VLTI capabilities toward shorter wavelengths (*J*- and *H*-bands), providing even higher spatial resolution than what is now possible with VINCI (*K*-band).

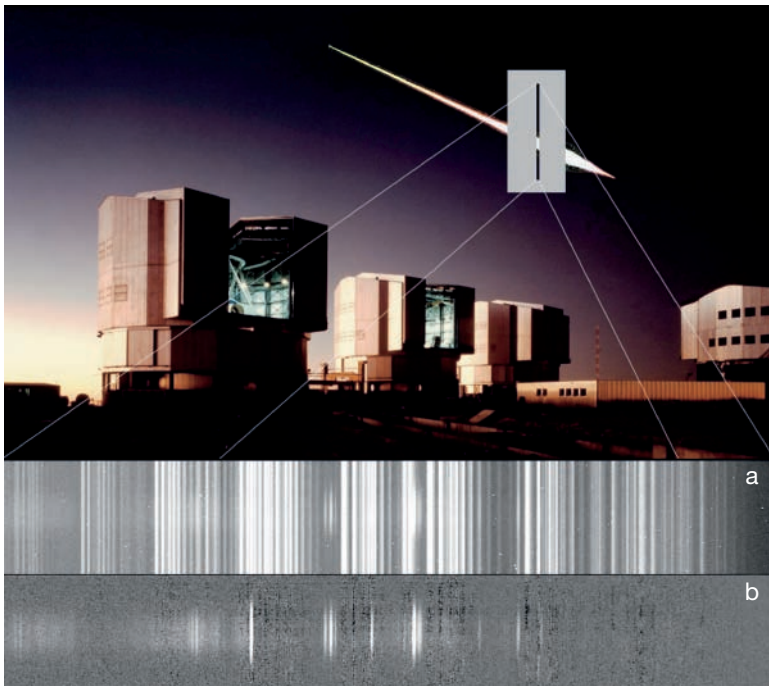
The combined effect of these two improvements will be to extend significantly the accessible sample of Cepheids. It is expected that the distances to more than 30 Cepheids will then be measurable with a precision better than 5 %. This will provide a high precision calibration of both the reference point (down to ± 0.01 mag) and the slope of the Galactic Cepheid Period-Luminosity.



The Period-Luminosity relation in the *V*-band, as deduced from the interferometric observations of Cepheids and the HST parallax measurement of Delta Cep.

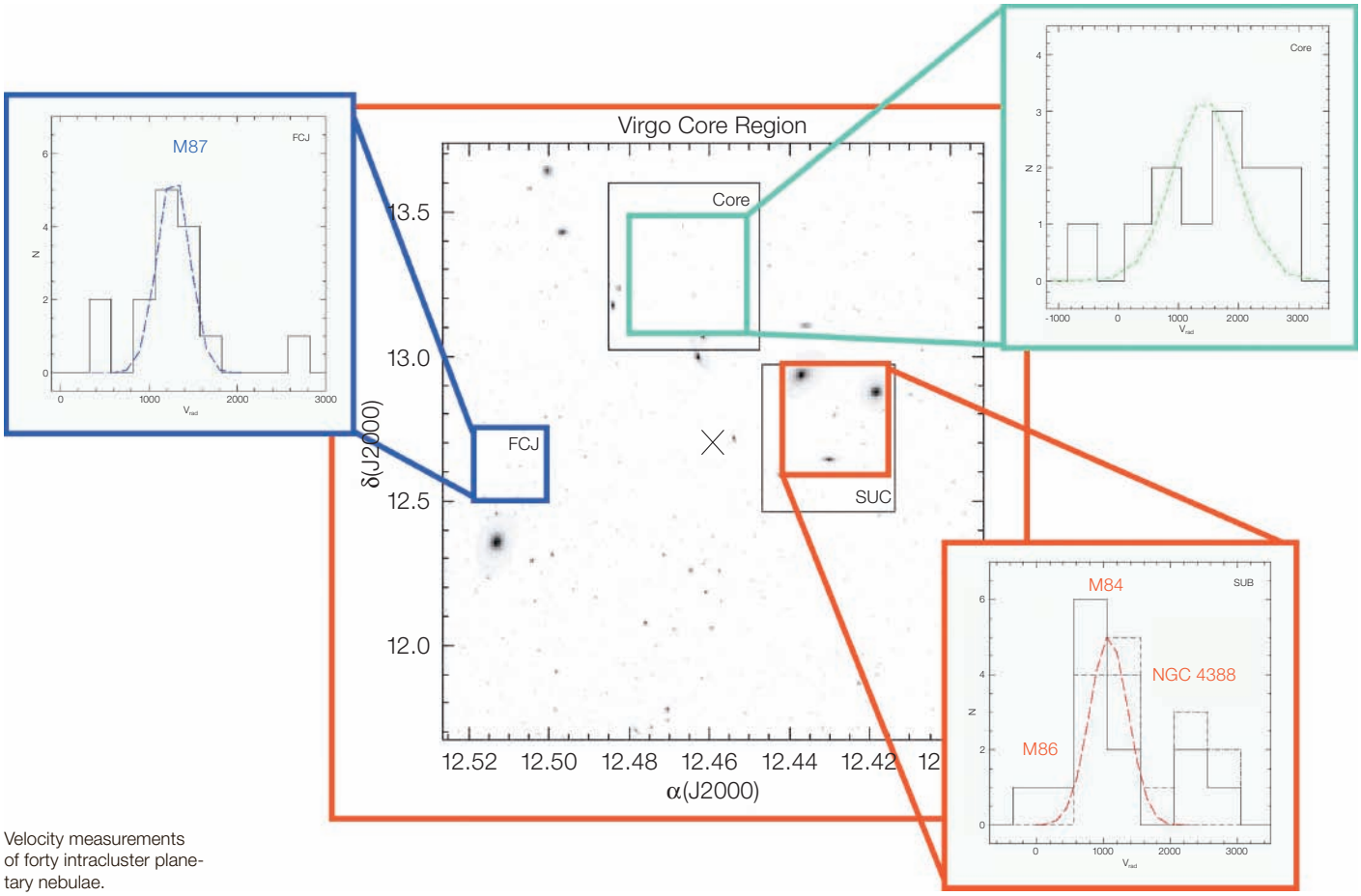
Spectrum of a meteor (FORS1/VLT)

On May 12, 2002, the FORS1 instrument on the VLT serendipitously recorded the spectrum of a bright meteor. This is quite possibly the only meteor spectrum recorded with a large telescope and a modern spectrograph. The spectrum covers the wavelength range from 637 to 1050 nm, which is dominated by emissions from air atoms and molecules in the meteor path and teaches us about the collision processes in the wake of a meteoroid. Closer inspection of the spectrum revealed about 20 tell-tale meteor emissions of oxygen and nitrogen atoms and nitrogen molecules. The ratio of atomic and molecular emissions could be used as a “thermometer” to measure the conditions in the meteor-induced hot gas in the wake of the meteoroid by means of laboratory measurements and meteor models that calibrate the VLT data. The meteor spectrum also provided a first view of such an object in the near-infrared window between wavelengths 900 and 1050 nm. This spectral region contains relatively strong lines of atomic carbon, but no such emissions were detected. This observation is important because it sets new constraints on the efficiency of meteor-induced atmospheric chemistry at the time when life began on our planet.



Most remarkable is the fact that the meteor trail was out of focus. The VLT is indeed focussed at infinity, which is perfect for most astronomical objects that it routinely observes. But not for meteoroids entering the atmosphere above Paranal. A point at 100 kilometres distance will appear as a small circle with 15 arcsec of diameter at the VLT focal plane. This corresponds to roughly half of the maximum apparent diameter of Mars in the evening sky!

Intergalactic stars



Velocity measurements of forty intracluster planetary nebulae.

At a distance of approximately 50 million light-years, the Virgo Cluster is the nearest galaxy cluster. It is located in the constellation Virgo (The Virgin) and contains many hundreds of galaxies, ranging from giant and massive elliptical galaxies and spirals like our own Milky Way, to dwarf galaxies, hundreds of times smaller than their big brethren.

Clusters of galaxies are believed to have formed over a long period of time by the assembly of smaller entities, through the strong gravitational pull from dark and luminous matter. The Virgo cluster is considered to be a relatively young cluster because previous studies have revealed small "sub-clusters of galaxies" around the major galaxies Messier 87, Messier 86 and Messier 49. These subclusters have yet to merge to form a denser and smoother galaxy cluster.

Recent observations have shown that the so-called "intracluster" space, the region between galaxies in a cluster, is permeated by a sparse "intracluster population of stars", which can be used to study in detail the structure of the cluster.

The first discoveries of intracluster stars in the Virgo cluster were made serendipitously in 1996 with the ESO New Technology Telescope at La Silla. Several planetary nebulae apparently not related to any galaxies but moving in the gravity field of the whole cluster were found. Planetary nebulae (PNe) can be detected out to large distances from their strong emission lines. These narrow emission lines also allow for a precise measure of their radial velocities. Planetary Nebulae can thus serve to investigate the motions of stars in the halo regions of distant galaxies.

Since these first observations, several hundreds of these "wanderers" have been discovered. They must represent the tip of the iceberg of a huge population of stars swarming among the galaxies in these enormous clusters. Indeed, as planetary nebulae are the final stage of common low mass stars – like our Sun – they are representative of the stellar population in general. And as planetary nebulae are rather short-lived (a few tens of thousand years – a flash on astronomical timescales), astronomers can estimate that one star in about 8 000 million of solar-type stars is visible as a planetary nebula at any given moment. There must thus be a comparable number of stars in-between galaxies as in the galaxies themselves. But because they are diluted in such a huge volume, they are barely detectable.

Because these stars are predominantly old, the most likely explanation for their presence in the intracluster space is that they formed within individual galaxies, which were subsequently stripped of many of their stars during close encounters with other galaxies during the initial stages of cluster formation. These "lost" stars were then dispersed into intracluster space where we now find them.

Thus, planetary nebulae can provide a unique handle on the number, type of stars and motions in regions that may harbour a substantial amount of mass. Their motions contain the fossil record of the history of galaxy interaction and the formation of the galaxy cluster.

To make a detailed study of the motions of the planetary nebulae in the Virgo cluster in order to determine its dynamical structure and compare it with numerical simulations, a challenging research programme, aimed at confirming intracluster planetary nebula candidates and measuring their radial velocities in three different regions ("survey fields") in the Virgo cluster core, has been undertaken, using the FLAMES-GIRAFFE spectrograph on the VLT.

A total of 107 stars, among which 71 were believed to be genuine intracluster planetary candidates, were observed in three parts of the Virgo core that contain several bright galaxies (Messier 84, 86, 87, and NGC 4388) and a large number of smaller galaxies. These regions were chosen to represent different entities of the cluster.

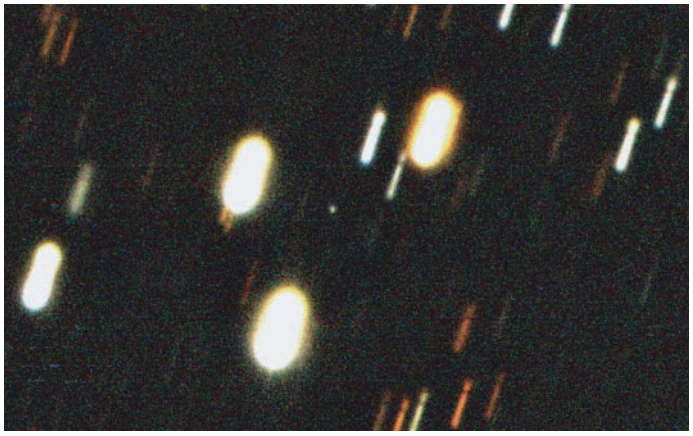
The spectroscopic measurements could confirm the intracluster nature of 40 of the planetary nebulae studied. They also provided a wealth of knowledge on the structure of this part of the Virgo cluster.

In the first field near Messier 87 (M87), the astronomers measured a mean velocity close to 1250 km/s and a rather small dispersion around this value. Most stars in this field are thus physically bound to the bright galaxy M87. Thus Messier 87 has a stellar halo in approximate dynamical equilibrium out to at least 65 kpc.

The velocity dispersion observed in the second field, which is far away from bright galaxies, is larger than in the first one by a factor of four. This very large dispersion, indicating stars moving in very disparate directions at different speeds, also tells us that this field most probably contains many intracluster stars whose motions are barely influenced by large galaxies. The new data suggest as a tantalizing possibility that this intracluster population of stars could be the leftover from the disruption of small galaxies as they orbit M87.

The velocity distribution in the third field, as deduced from FLAMES spectra, is again different. The velocities show substructures related to the large galaxies Messier 86, Messier 84 and NGC 4388. Most likely, the large majority of all these planetary nebulae belong to a very extended halo around Messier 84.

Taken together, these velocity measurements confirm the view that the Virgo Cluster is a highly non-uniform and unrelaxed galaxy cluster, consisting of several subunits. The Virgo Cluster is thus still in the making.



The nucleus of
Comet 67P/Churyumov-Gerasimenko

In the morning of March 2, 2004, the Rosetta spacecraft was launched on board an Ariane-5 launcher from the European Spaceport in Kourou, French Guiana. The European Space Agency (ESA) spacecraft will be the first to land on a comet. Before the launch, and as a salute to their colleagues at ESA, astronomers used the New Technology Telescope to image Rosetta's target, Comet 67P/Churyumov-Gerasimenko. These new images show the object at a distance of approximately 670 million kilometres from the Sun – 4.5 times the distance from the Earth to the Sun. The observations provide further confirmation that at this distance the activity on 67P/Churyumov-Gerasimenko is very low.
This is very good news for the mission, because it means that when Rosetta meets its target comet in 2014, at 790 million kilometres from the Sun, there will not be so much dust near the nucleus to hinder the landing.

Closer to the monster

Active galaxies are among the most exotic objects in the sky. Their compact nuclei are so luminous that they can outshine the entire galaxy; “quasars” constitute extreme cases of this phenomenon. These cosmic objects show many interesting observational characteristics over the whole electromagnetic spectrum, ranging from radio to X-ray emission.

There is now much evidence that the ultimate power station of these activities originate in supermassive black holes with masses up to thousands of millions times the mass of our Sun. The one in the centre of our Milky Way galaxy has only about 3 million solar masses. The black hole is believed to be fed from a tightly wound accretion disc of gas and dust encircling it. Material that falls towards such black holes will be compressed and heated up to tremendous temperatures. This hot gas radiates an enormous amount of light, causing the active galaxy nucleus to shine so brightly.

NGC 1068 is among the brightest and most nearby active galaxies. Located in the constellation Cetus (The Whale) at a distance of about 50 million light-years, it looks like a rather normal, barred spiral galaxy. The core of this galaxy, however, is very luminous, not only in optical, but also in ultraviolet and X-ray light. A black hole with a mass equivalent to about 100 million times the mass of our Sun is required to account for the nuclear activity in NGC 1068.

In June 2003, a first series of observations with the MIDI instrument on the VLTI studied the active galaxy NGC 1068, showing unprecedented details near the centre of this object.

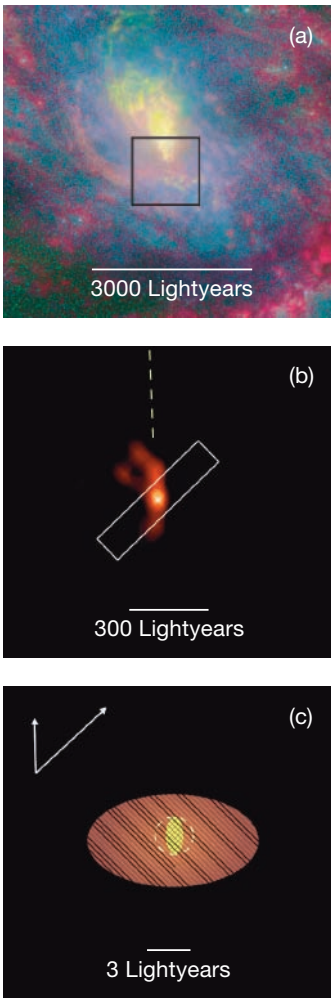
Additional interferometric observations were made in November 2003 at a baseline of 42 m. Following a careful analysis of all data, the achieved spatial resolution (image sharpness) and the detailed spectra have allowed astronomers to study the structure of the central region of NGC 1068.

An innermost, comparatively “hot” cloud of dust, heated to about 500 °C and with a diameter equal to or smaller than the achieved image sharpness, i.e. about 3 light-years, was detected. It is surrounded by a cooler, dusty region, with a temperature of about 50 °C, measuring 11 light-years across and about 7 light-years thick. This is most likely the predicted central, disc-shaped cloud that rotates around the black hole.

The comparative thickness of the observed structure (the thickness is ~ 65 % of the diameter) is of particular relevance in that it can only remain stable if subjected to a continuous injection of motion (“kinetic”) energy. However, none of the current models of central regions in active galaxies provide a convincing explanation of this.

The MIDI spectra, covering the wavelength interval from 8–13.5 µm, also provide information about the possible composition of the dust grains. The most likely constituent is calcium aluminium -silicate ($Ca_2Al_2SiO_7$), a high-temperature species that is also found in the outer atmospheres of some supergiant stars. Still, these pilot observations cannot conclusively rule out other types of non-olivine dust.

These are the first-ever long-baseline imaging and spectral interferometric observations of an extragalactic object in the thermal infrared. They open the door to a completely new field in astronomy: the study of gas and dust structures surrounding and feeding the heaviest black holes in the universe.



The central region of NGC 1068.

The constancy of fundamental physical constants

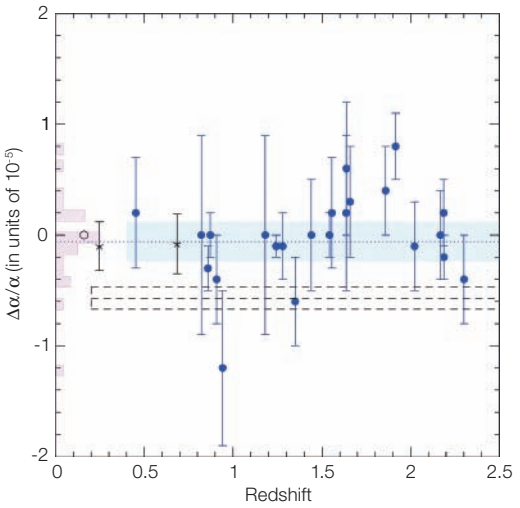
To explain the Universe and to represent it mathematically, scientists rely on so-called fundamental constants or fixed numbers. The fundamental laws of physics, as we presently understand them, depend on about 25 such constants. Well-known examples are the gravitational constant, which defines the strength of the force acting between two bodies, such as the Earth and the Moon, and the speed of light.

Another of these constants is the so-called "fine structure constant", α = 1/137.03599958, a combination of electrical charge of the electron, the Planck constant and the speed of light. The fine structure constant describes how electromagnetic forces hold atoms together and the way light interacts with atoms.

But are these fundamental physical constants really constant? Are those numbers always the same, everywhere in the Universe and at all times? Contemporary theories of fundamental interactions, such as Grand Unification Theories or superstring theories that try to treat gravity and quantum mechanics in a consistent way, not only predict a dependence of fundamental physical constants with energy – particle physics experiments have shown the fine structure constant to grow to a value of about 1/128 at high collision energies – but allow for their cosmological time and space variations. A time dependence of the fundamental constants could also easily arise if, besides the three space dimensions, there exist more hidden dimensions.

New studies have provided stringent constraints on the possible value of the fine structure constant when the Universe had only 25 % of is present age, that is, about 10 000 million years ago.

The fine structure of atoms can be observed spectroscopically as the splitting of certain energy levels in those atoms. So if α were to change over time, the emission and absorption spectra of these atoms would change as well. One way to look for any changes in the value of α over the history of the Universe is therefore to measure the spectra of distant quasars and compare the wavelengths of certain spectral lines with present-day values.



Relative changes with redshift of the fine structure constant.

Quasars are here only used as beacons in the very distant Universe. Interstellar clouds of gas in galaxies, located between the quasars and us on the same line of sight and at distances varying from six to eleven thousands of million light years, absorb parts of the light emitted by the quasars. The resulting spectrum consequently presents dark "absorption features" that can be attributed to well-known elements.

These measures are however extremely delicate and require a very good modelling of the absorption lines. They also put exceedingly strong requirements on the quality of the astronomical spectra. They must have enough resolution to allow very precise measurement of minuscule shifts in the spectra. And a sufficient number of photons must be captured in order to provide a statistically unambiguous result.

In one study, a very careful examination of a homogeneous sample of 50 absorption systems, observed with UVES and Kueyen (UT2) along 18 distant quasars lines of sight, was performed. The spectra of quasars were recorded over a total of 34 nights to achieve the highest possible spectral resolution and the best signal-to-noise ratio. Extensive simulations were made to show that the line profiles could be correctly modelled to recover a possible variation of α.

The result of this extensive study is that over the last 10 000 million years, the relative variation of α must be less than 0.6 part per million. This is the strongest constraint from quasar absorption lines studies to date. More importantly, this new result does not support previous claims of a statistically significant change of α with time.

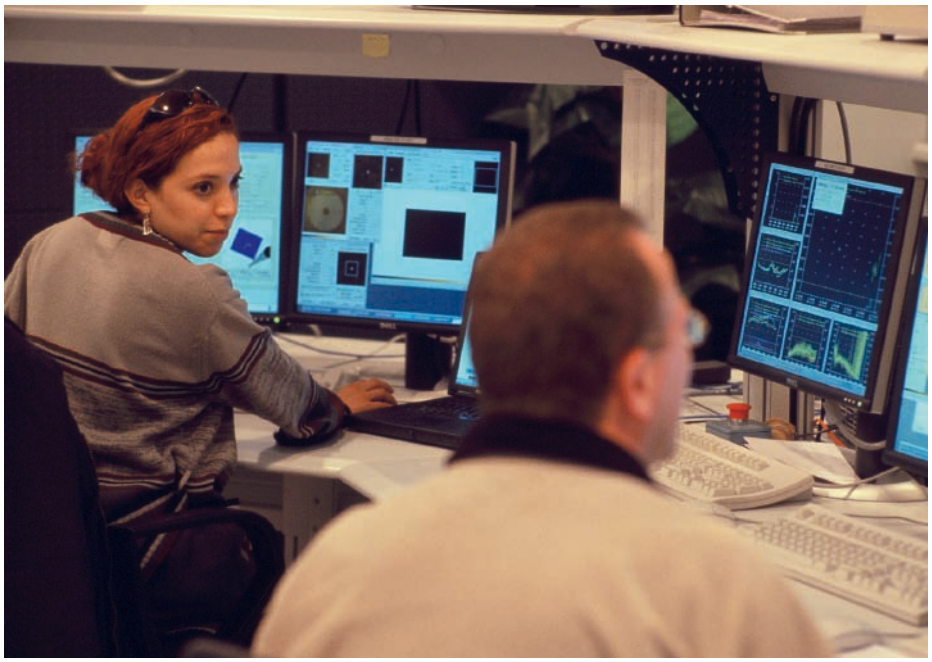
Interestingly, this result is supported by another – less extensive – analysis, also conducted with the UVES spectrometer on the VLT. Even though those observations were only concerned with one of the brightest known quasar HE 0515-4414, this independent study lends further support to the hypothesis of no variation of α.

Other fundamental constants can be probed using quasars. In particular, by studying the wavelengths of molecular hydrogen in the remote Universe, one can probe the variations of the ratio between the masses of the proton and the electron. This work is currently in progress.

Composite colour-coded image – based on observations with the multi-mode VIMOS instrument on the ESO VLT – of the magnificent spiral galaxy, NGC 7424, at a distance of 40 million light-years.

Paranal Observatory

At the control station of Melipal (UT3).



This was again a year of growth for Paranal. Growth in the number of instruments offered to the community, growth in the number of new instruments installed, growth in the number of telescopes present on the site and growth in the capabilities of the instrumentation already on offer. We celebrated the 5th year of science operations for the first Unit Telescope of the Very Large Telescope array and our 800th scientific paper from the observatory. We also celebrated the coming of age of the VLT Interferometer.

The VLT is as successful as ever among its users' community. The average pressure factor (requested time/available time) on the VLT Units was above four, with a continuing large demand for service observation mode.

Paranal is continuously breaking new ground in the scientific arena while pushing the technological boundaries in new instrumentation and the interferometer. In parallel, the robust and efficient operations of the telescopes continuously feed the ESO archive with data. Using the data stored in the VLT archive, and tools developed for the Virtual Observatory, it has been possible to show that the number of supermassive black holes in the universe exceeds previous expectations by more than a factor of 2. Robust and efficient operations, however, do not stifle innovation at Paranal. A new spectral differential imager is now operational in the CONICA camera. An addition proposed after the instrument was released into operations, this optical element (designed by a team from the Max-Planck-Institut für Astronomie in Heidelberg and the University of Arizona) allows simultaneous images of an astrophysical target in a number of different wavelengths. Exceptional images of the Saturn moon Titan were obtained before the arrival of the Cassini space probe using this facility. Other new elements in CONICA are a prism to allow broader wavelength coverage and a half waveplate. A new detector was installed into CONICA and UVES on UT2 also received a new detector during 2004.

NACO has provided us with our first direct image of a candidate exoplanet. With the versatility of the VLT at hand and the ability to observe with multiple instruments on different telescopes simultaneously, planets transiting in front of a star were detected and the radial velocity changes measured directly. These so-called "very hot Jupiters" have now been confirmed, thanks to the VLT.

With MIDI in common user operations, the VLT interferometer has truly come of age. The unique combination of enormous collecting area, multiple baselines and state of the art instrumentation makes the VLTI a leader in its field. Spectroscopy in coherent light has allowed MIDI to examine closely the circumstellar discs of young stars and the nucleus of NGC 1068. Looking deep into the cores of objects, previously impossible has opened new horizons for the astronomical community of Europe.

The mechanism for the formation of high mass stars was directly observed by combining observations from Paranal and La Silla as well as the IRAM Plateau de Bure interferometer. In this case, ISAAC, EMMI and EFOSC observations were combined to image and take spectra of a massive star in Orion showing evidence for an accretion disc.

Late afternoon at Paranal.

One million data headers

All aspects of the ESO end-to-end science operations system are critically reliant on database technology. To this end, ESO operates several enterprise-class database servers in Germany and Chile in a coordinated fashion. The DFO CAS group has overall responsibility for administering these systems, in coordination with the observatories in Chile. The technology and complexity of the ESO database management system rivals that of major commercial enterprises, such as the international banking community. ESO was recently recognized for excellence in this area by Sybase (our main database server vendor), which nominated ESO for the Computerworld Honors Program, a well-known award in the international IT community. During 2004, the ESO database server grew to 31 databases for a total size of 135 GB. More than one million data headers and four million keywords were transferred between Paranal and Garching, extending the database volume by about 5 GB. The data warehousing system that hosts the Paranal ops_log archive reached the one billion entry milestone in March 2004. This warehouse is growing by approximately 900 000 entries per day. A key component of the system, the replication server that manages synchronization of data between Germany and Chile, was upgraded.

Final preparation of AT1.

In 2004, there was considerable movement of instruments on Paranal. FORS2 was moved from UT2 to UT1, and FORS1 from UT4 to UT2, SINFONI mounted at the Cassegrain focus of UT4 and VISIR at the Cassegrain focus of UT3. SINFONI is an adaptive optics-fed integral field spectrograph working in the near infrared. VISIR is a mid-infrared imager and spectrograph providing a variety of resolutions. Both instruments had successful commissioning runs and following science verification were offered to the community for the period starting in April 2005. AMBER, the three-beam instrument for the VLTI was installed and achieved First Fringes with 2 Unit Telescopes in March and with 3 in May. The latter is a world first with telescopes larger than 1-m. After correcting for fast vibrations in the VLTI environment, good performance in terms of fringe visibility was obtained in the fall. It is expected that AMBER will be offered to the community in the second half of 2005.

The first science instrument on the VLTI, VINCI, is not used any more for astronomical observations, but remains an important test facility to evaluate the VLTI performance in the interferometric laboratory and when commission new facilities. Its ailing bulk beam combiner was replaced in the summer by LAOG-Grenoble, in collaboration with IMEP and LETI, by the IONIC device, using an innovative integrated optics technology approach.

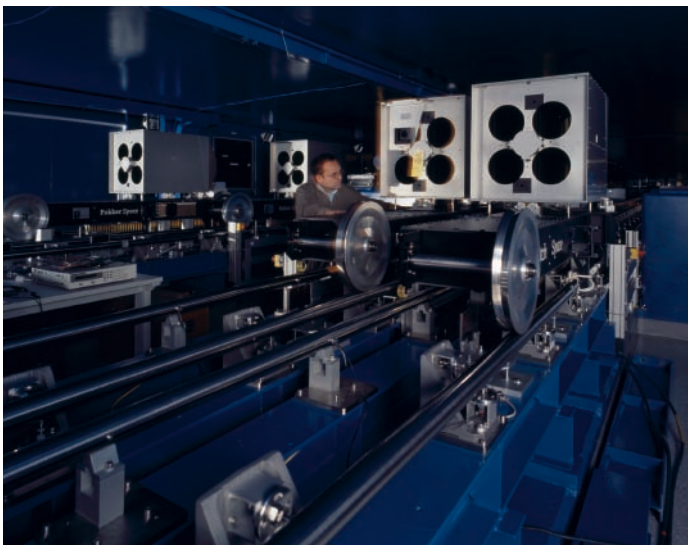
Commissioning of the Fringe tracking system for the VLTI (FINITO) took place during 2004 and although a lot was learnt, the system has not yet reached operational status. The same situation is true for the variable curvature mirrors of the VLTI delay lines. The three existing delay lines have been augmented by three more, which were installed in the first half of the year.

It has been quite some time since the observatory had a new telescope and the arrival of the first of four Auxiliary Telescopes (AT1) on the deck of Paranal was a welcome addition. Extensive commissioning took place, and with the arrival of the second Auxiliary Telescope at the site the VLT Interferometer Sub-Array (VISA), part of the VLTI programme, is now well on its way to completion. First Fringes with the two ATs are expected in early 2005.

With three of the four UTs now equipped with MACAO systems for VLTI (the fourth is planned for early 2005), Paranal now hosts 5 adaptive optics systems in total. With 2 more coming in 2005 (MACAO on UT1 and CRIRES) Paranal is clearly at the forefront of adaptive optics deployments in the astronomical community.

Also with the Integral Field Units on VIMOS, FLAMES and now SINFONI, this area of the observing parameter space is rapidly being filled up.

Maintenance of the VLTI delay lines.



CO_2 cleaning of the AT2 primary mirror.

The PRIMA star separators, fringe sensor units, metrology system and differential delay lines have advanced well during the year with start of deployment of that new facility in Paranal next year. Preliminary definition of potential second-generation VLTI instruments is progressing under the European Interferometry Initiative umbrella, with formal presentations planned at a dedicated Workshop in April 2005. In addition, the two competing definition studies by industries of the DARWIN ground precursor GENIE were completed and were evaluated by ESA and ESO; this may lead to a common-user VLTI instrument in the future.

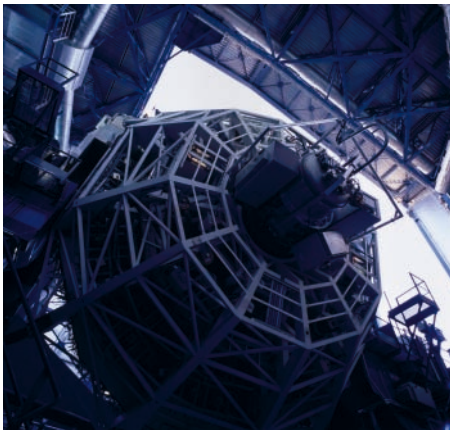
The overall performance of the Unit Telescopes remains at the highest levels. UT1 science availability during 2004 was 345 nights (or 94 % of the time). The remainder was split between technical activities and commissioning. For UT2 the equivalent number was 91%, with more commissioning time being used for VLTI. UT3 and UT4, with one instrument offered to the community and substantial commissioning activities for SINFONI, VISIR, AMBER and MACAO-VLTI, were available for science for 70 % of the year. We have naturally concentrated the commissioning activities in the bright time that the VIMOS instrument would not normally use and therefore they have had very little impact on the science produced by the telescopes.

Science efficiency also remained very high. The technical downtime was 7.5, 7.8 and 10.7 nights (or 2.2 %, 2.3 % and 4.0 % of the science time) on UT1, UT2 and UT4 respectively (i.e. less than two hours per week per telescope). On UT3 we had a failure of the coating chamber during a primary mirror recoating that took several days to fix. The total technical downtime on UT3 was 14.0 %. Of this, 8.7% was due to VIMOS, showing a definite improvement on the previous year thanks to the various interventions by the instrumentation division. Weather downtime was below 9 % of the science time (this varies slightly from telescope to telescope depending on the instruments used: for example it was 8.1 % for UT1 and 8.9 % for UT2).

In 2004 a major activity was the consolidation of the plan to merge the La Silla and Paranal observatories into a single entity. Early mergers were the mechanical and software groups of the engineering departments of the two sites. La Silla was already contributing to the success of the Paranal operation by performing the maintenance of the passive supports of the primary mirror cells of the Unit telescopes of the VLT. Also, La Silla staff had been participating in coating activities at Paranal, while training of new software engineers is now undertaken at La Silla.

Instrument Pipelines

Support for the IFU mode of VIMOS was implemented, delivered to the operation teams and to the user community in summer 2004. The software produces extracted, wavelength calibrated, transmission corrected science spectra plus a reconstructed spatial image of the field of view integrated on a predefined wavelength interval. In addition, a new version of *Gasgano* was made available to the public. *Gasgano*, a data management tool used on Paranal and as a desktop application for many years, allows, in its newest release, pipeline recipes to be executed directly on a set of user-selected files. The SINFONI Data Reduction Software delivered by the instrument consortium was integrated into the ESO pipeline infrastructure, installed, verified and validated during the commissioning of the instrument. The SINFONI pipeline comprises a set of recipes for evaluating the detector's linearity, generating master flat fields, master darks and bad pixel masks, computing the detector's distortions and the slitlets, distances, reducing science spectra and generating QC parameters. Science products are wavelength calibrated cubes. Finally, the MIDI pipeline was released for science operations and was used to process observations of period 73.



SINFONI at Yepun.

VLT Operations

The VLT Observatory is a distributed facility. The Paranal Observatory, Data Management division (DMD) and Visiting Astronomers Section (VISAS) work together to make the VLT operational through an end-to-end system. In DMD, the User Support Department and the Data Flow Operations Department are part of VLT operations.

The User Support Department (USD), through the ESO Data Flow System, provides help for Phase 1 proposal preparation, and support, review, and optimization during the preparation of Phase 2 material. USD is responsible for collecting all information necessary for Service Mode programme execution, and verifying its compliance with the policies that have been defined to ensure the viability and efficiency of service mode operations. As necessary, USD personnel work directly with users to make sure their preparations are technically and scientifically correct. The certified material is made available to Paranal Science Operations and to the La Silla imaging force for short-term scheduling and execution. During Periods 73 and 74, a total of 875 Service Mode observing runs were supported by USD. USD also participates in the planning of operations of future instrumentation. Besides "lessons learned" meetings to assimilate the experience accumulated in the first months of MIDI operations, USD astronomers participated during 2004 in early activities with new instruments due to start operations in 2005, namely VISIR, SINFONI, and AMBER. They also studied and provided requirements on future tools to support the preparation and execution of surveys in VISTA and VST.

The responsibilities of the Data Flow Operations (DFO) department can be broken down into four areas: science archive operations, archive database content management, Paranal Observatory data processing and quality control, and archive IT system and database administration. The DFO Quality Control (QC) group is responsible primarily for the monitoring and reporting of basic instrument performance for all VLT/VLTI instruments as well as the creation of various calibration and science data products for these instruments. QC works closely with the Paranal Science Operations (PSO) department to ensure that VLT/VLTI instruments are always performing within expected and published ranges. During 2004, QC processed 337 449 raw frames (+ 36 % relative to 2003), produced 237 108 (+ 60 %) science and calibration data products, and created 667 (+ 15 %) Service Mode data packages. The increased output was made possible primarily by increased time allocations for MIDI, GIRAFFE and VIMOS. However, most instruments showed at least some increase in all three areas, indicating once again the continued demand for Service Observing from the VLT/VLTI user community.

The VISTA enclosure at the end of 2004.

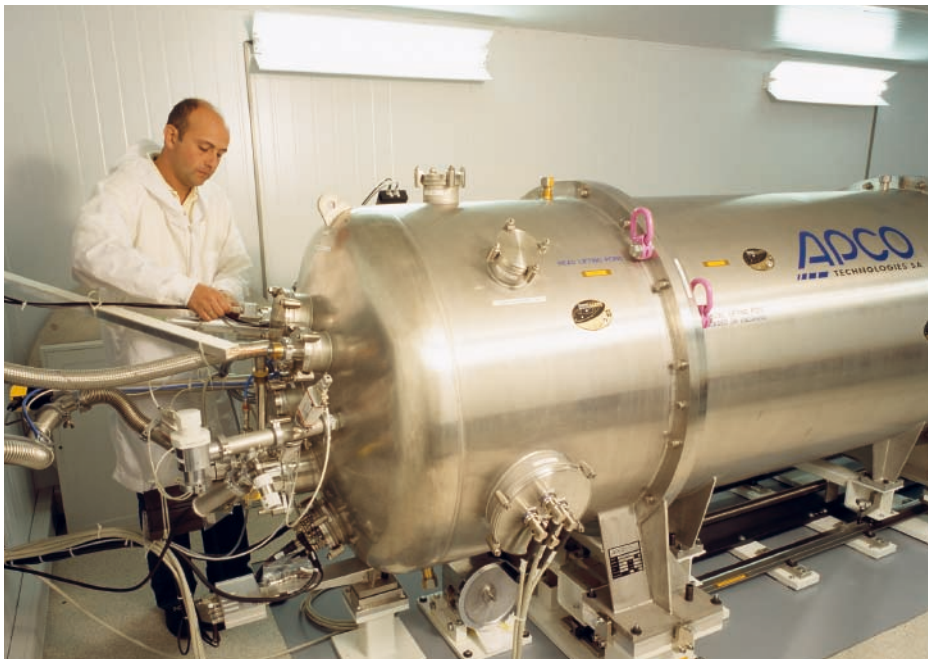
VISTA

The VISTA 4.2 m wide-field infrared survey telescope is being acquired by ESO under the terms of the UK accession agreement, and is being developed for PPARC (the UK Particle Physics and Astronomy Research Council) by the UK Astronomy Technology Centre in Edinburgh. The telescope will be located about 2 km East of the VLT platform and is planned to start operation in 2007.
During 2004, the Final Design Reviews of all the remaining subsystem contracts were completed, including the infrared camera (January), the M2 unit (February), the enclosure (May), the telescope structure (June) and the coating plant (October). On site, the concrete work for the enclosure has been completed and the framework for the rotating structure has been erected.

A critical milestone of the project was the delivery of the sixteen, science-grade 2,000 x 2,000 HgCdTe detectors that are required for the infrared camera focal plane. These have now all been delivered by the manufacturer and are now being evaluated at the Rutherford Appleton Laboratory using the ESO-supplied IRACE control electronics. Because VISTA must be fully compatible with Paranal infrastructure and standards, ESO has provided technical and on-site logistic assistance to the project.

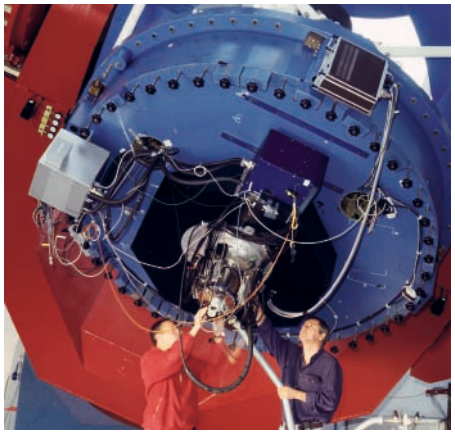
La Silla Observatory

The HARPS instrument.



La Silla became the first observatory in the world to receive the International Organization of Standardization ISO9001:2000 certification. A team of international auditors audited the Quality Management System implemented at the observatory and granted the certification thus ensuring the highest possible quality level. Clearly, the great strategic advantage of the ISO 9001 approach is the continuous improvement of all the core processes of the observatory. The certification is just the beginning. The preparations for merging La Silla and Paranal into a single observatory – The La Silla Paranal Observatory (LPO) – were completed. As you read these pages, ESO will be operating only one observatory in Chile, the LPO, albeit with three sites! The La Silla telescopes continued to operate with high efficiency and high user satisfaction this year. In terms of down time, the long term goal of less than 2 % loss of time due to technical problems was comfortably achieved – in part owing to the ISO 9001 process. In fact, the performance is almost at the 1 % level – a remarkable achievement if one considers that 1 % loss corresponds to a mere 3 hours in one month. User satisfaction, as measured by the end of mission reports, was above 70 % for all services, reaching 80 to 90 % for technical support and telescope operators. Only off-line computing facilities was rated at 60 % satisfaction.

The OPTICON programme designed to provide access to La Silla telescopes for researchers of European non-ESO member countries started this year. While the number of nights allocated – through the usual ESO OPC process – to OPTICON access projects was quite small, the programme is working and should in time provide observing opportunities at La Silla in particular to astronomers in new EU member states, as their know-how reaches the levels required to pass OPC scrutiny.



The Wide Field Imager at the 2.2-m ESO/MPG telescope.

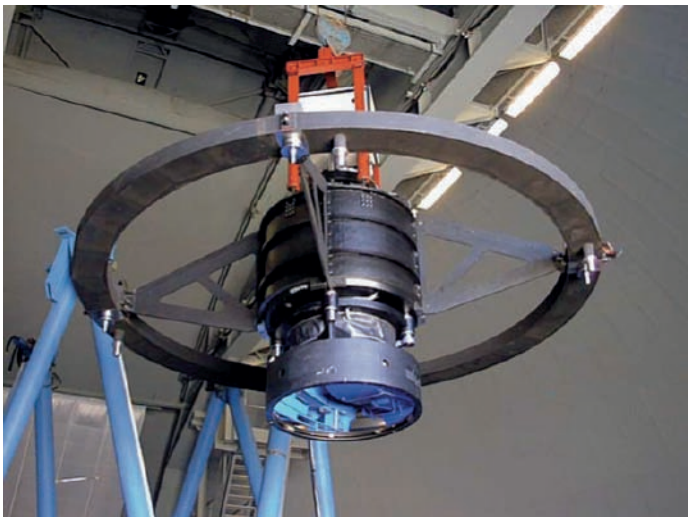
The average pressure factor (requested time/available time) on the 3.6-m was 4.5, 2.1 for the NTT, and 1.3 for the ESO/MPG 2.2-m telescope. The observing schedule was essentially Visitor Mode-based, with about 10 % of the available nights assigned to Service Mode on the NTT and 3.6-m telescopes. At the 2.2-m telescope, the largest fraction of the scheduled time with the Wide Field Imager (WFI) was assigned to Service Mode.

A number of improvements were introduced to increase the efficiency of our telescopes. The full upgrade of the 3.6-m telescope was completed this year with the replacement of the complete F/8 top-end of the telescope. Everything, from the top ring and spiders to the collimation and focusing mechanisms was changed or implemented, leaving only the secondary mirror and its cell. The improvements were immediately noticeable: better image quality (no coma), no image degradation with telescope attitude, no hysteresis, and reproducible focus. The specific impact on operations of the HARPS high resolution spectrograph was particularly impressive: a full factor of 2 in efficiency! No doubt scientific discoveries will soon follow. HARPS has already proved to be a unique tool for the detection of extra-solar planets from minute radial velocity variations of their parent stars, having detected for the first time a rocky planet of about 14 Earth masses (see the Research Highlights section).

REM, the 60-cm robotic telescope that will scout the southern skies in search of the elusive optical/IR counterparts of gamma-ray bursters, was commissioned and started to work routinely towards the end of the year. ESO is thus ready to respond in the fastest possible way to gamma-ray alerts from the SWIFT satellite and other space observatories dedicated to the exploration of the high-energy universe.

The optics of the La Silla DIMM were replaced by new ones. This led to a significant improvement in the image quality and of the signal level. As a consequence, the seeing measurements are now more accurate and can be performed on fainter stars.

Not only was the actual performance of some of the instruments and telescopes enhanced, but also the possibility for observers to make decisions on-line was upgraded. A suite of easy to use, fast data reduction procedures and mini-pipelines allows observers to assess the quality of their data on line and in real time. La Silla also led the process of upgrading the on-line data reduction computers to state-of-the art LINUX machines which in some cases improved the data processing speed by more than one order of magnitude! Other improvements included the porting of the data archiving of most instruments to the Next Generation Archive System (NGAS), moving the EFOSC multi-object spectra punch to the central integrated control room (the “RITZ”), upgrading the Exposure Time Calculators for all instruments, etc. Unfortunately, there are glitches with SOFI, which requires a major overhaul to be cured.



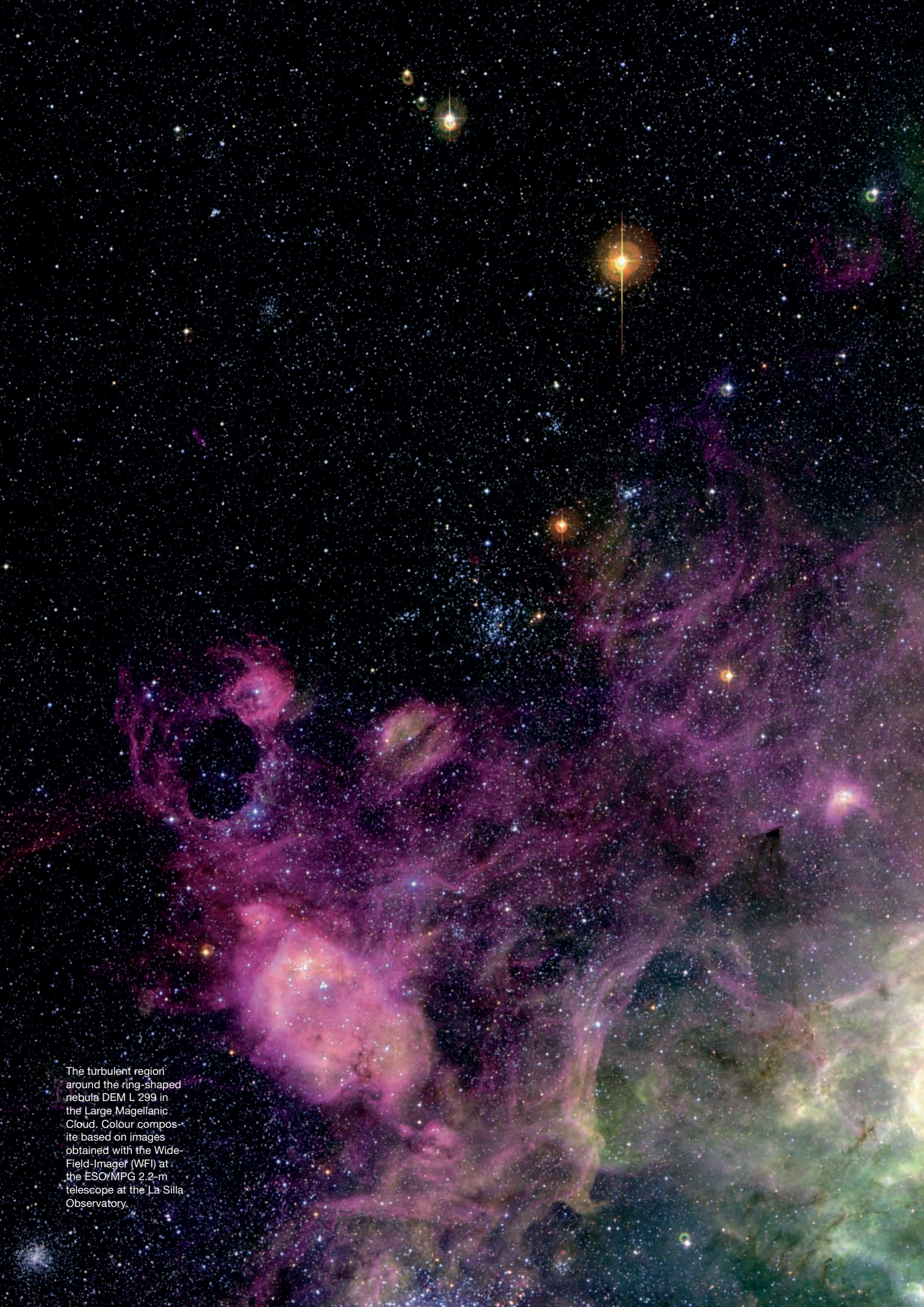
The new 3.6 F/35 unit being mounted on the Serrurier.

The La Silla University (LSU), the structure designed a few years ago to cater to the training needs of the staff, both newly arrived and experienced ones, matured this year. On the basis of training plans developed by supervisors for each and every member of the staff, LSU programmed a curricular mesh and implemented a virtual eCampus for staff who for any reason could not attend the courses. LSU, which actually fulfills a requirement of the ISO 9001 standard, became a bona-fide teaching institution in 2004.

Observation Preparation tools

Astronomers applying for observing time at ESO must submit a description of the observations to be carried out in the form of an observing proposal. The Data Flow System group of the Data Management Division has worked hard over the past two years to replace the existing system based on e-mail and Latex by a new one: Since March 2004, astronomers now submit their observing proposals through the Web.

View of the La Silla University Web page.



The turbulent region around the ring-shaped nebula DEM L 299 in the Large Magellanic Cloud. Colour composite based on images obtained with the Wide-Field-Imager (WFI) at the ESO/MPG 2.2-m telescope at the La Silla Observatory.

Chajnantor

During the year the ALMA construction phase has become established and substantial progress has been made. The procurement of the production Antennas has, however, been a more timeconsuming and complicated process than originally thought and has not been satisfactorily resolved within the original project timescale. This delay has necessitated a new look at both project requirements and, because of the stringent budget limitations, the overall project aims. This "re-baselining" of the project is to be undertaken in early 2005 and will most likely result in a reduced number of antennas in the array whilst maintaining as far as possible the scientific aims of the project.

Under the Director, Massimo Tarenghi, staffing of the Joint ALMA Office (JAO) in Santiago has proceeded well with the appointment of Tony Beasley as JAO Project Manager and Rick Murowinski as JAO Project Engineer, mainly devoted to the task of System Integration in Chile. The post of JAO Project Scientist has yet to be filled. The new ALMA JAO dedicated office in Santiago was officially opened on November 1 and all JAO personnel are co-located.

John Credland took over as European project manager and ALMA Division head at the beginning of the year. Ferdinand Patt joined the Front End team in August and Donald Tait joined as the Scheduler at the same time. Recruitment of engineers for the Antenna and Back End teams is still ongoing with several more posts being opened in 2005. Negotiations are still ongoing between the two Executives regarding the common hiring of local staff in Chile for the observatory. It is envisaged that some operational staff will be hired in the near future and trained during the integration phase to form the basic maintenance team for the operational phase.

Several major activities occurred during the year but the highlights were the 5th Heads of Institute meeting held in early September and the ALMA Community day held in late September. Both these meetings forged links between the Management of the many European Institutes contributing to ALMA , the ALMA Scientific community and the ESO project office.

As well as regular teleconferences, face-to-face meetings of the ALMA Board took place in April (Socorro, NM), June (Munich) and November (OSF, San Pedro de Atacama). They were always preceded by European ALMA Board (EAB) teleconferences and meetings. The ALMA Management Advisory Committee (AMAC) met in March in Charlottesville VA and in October in Florence while the ALMA Science Advisory Committee (ASAC) met in May in Cambridge and in September in Charlottesville VA. In addition two "ALMA weeks" were held, one at Schloss Elmau in Garmisch and the second in Charlottesville VA. These meetings bring all ALMA project participants together for an in-depth review of the project status and are essential for fostering the "one project" feeling amongst team members spread far and wide.

The negotiations with Japan culminated in the signing of an agreement between the ALMA Bilateral partners and the Japanese Institute of Science for the provision by Japan of a compact array consisting of four 12-m antennas and twelve 7-m antennas to be installed close to the main ALMA array. The agreement for the "Enhanced ALMA" foresees independent construction programmes using common interfaces followed by a cooperative operational programme.

Construction Work

Work on the Site has advanced rapidly since the "Ground Breaking Ceremony" in November 2003. The 42 km of roadway between Highway 23, the Operational Support Facility (OSF) and the Array Operations Site (AOS) has been largely completed to its final operational state.

The tender for the OSF technical facilities is ready for issue and it is planned to place the contract by the end of 2005. This date is later than originally envisaged but will still meet the project schedule resulting from the delay introduced by the production antenna procurement. Work has commenced on the mass excavation for the OSF technical facilities and the spoil generated has been reused for road fill.

Sunrise at the Operational Support Facility (OSF) site.

A Tender for the design of the dual-fuel power generation system for installation at the OSF is ready for issue and it is expected that a contract will be placed in mid 2005. This system will supply power for both the OSF and the AOS sites, the AOS being supplied by underground cable to comply with the environmental requirements.

The ALMA camp, for the use of ALMA personnel when on site at the OSF, has been completed and is now occupied with all essential services operational. The ALMA Board meeting in November was hosted in the ALMA offices at the OSF. The Contractors' camp, for housing all contractor personnel during the construction of the road, OSF and AOS sites, is almost complete and ready for operation.

Antennas

The Antenna Evaluation Group (AEG) continued its measurement programme on the Vertex prototype at the ALMA Test Facility near Socorro, New Mexico. This programme was completed in late March. Meanwhile the Alcatel/EIE prototype antenna "punch list" was being completed following preliminary acceptance in December 2003. The AEG shared time on the antenna with the contractor until late March and was then given a further month of unrestricted access to complete their measurement programme. The report of the AEG covering the performance of both prototype antennas was issued to the two Executives at the end of May.

The ALMA prototype antennas at the VLA site at Socorro, New Mexico.

In the meantime, detailed analysis of the AEG report data raised a number of technical queries which, of necessity, influenced the ongoing evaluation of the production antenna bids. In order to reaffirm the measurements taken on the two prototypes a further series of detailed measurements were planned and executed from August till the end of the year. These measured data have been reduced by a group of independent, internationally-recognized scientists/engineers and a final report is expected by the end of February 2005. This report to the Executives will be a crucial milestone in the completion of the production antenna technical evaluation programme.

The joint Call for Tender for the production antennas was issued by the two Executives in December 2003 with responses due at the end of April 2004. In the event, Europe received three bids and North America two bids by the closing date. The two bids received by North America were also received by Europe, the extra bid being solely sent to Europe.

Technical and Managerial evaluation of the bids was carried out by a Joint Technical Evaluation Group comprising both European and North American representatives. Once the technical evaluation was complete each Executive evaluated the Contractual and Financial bids separately in order to comply with the differing procedures of the two Executives. Evaluation is still ongoing at the time of writing.

Hardware

The first pre-production cryostat was successfully accepted from the Rutherford Appleton Laboratories (RAL) and delivered to NRAO, Charlottesville for use in the testing of the Band 3 and 6 receiver cartridges being supplied by North America. The development of two competing Water Vapour Radiometers at Cambridge University and Onsala Space Observatory has been completed and both prototypes are currently under test. At a later date they will be integrated into the prototype antennas in Socorro for in-situ comparison testing. Prototyping of the cryogenic low noise amplifiers for each both band 7 and band 9 receivers was successfully completed by CAY in Spain and production is expected to start in early 2005.

Development of the 4 Ghz digitizer sampler/demultiplexer/digitizer clock has proceeded successfully at the University of Bordeaux. The second generation of digitizer chips has been produced and is currently in the final phases of test. Several complete digitizer assemblies based on the first generation chips have been delivered to NRAO for system testing.

Jodrell Bank Observatory has successfully developed fibre optic components for the digital transmission system and will continue to production of the receive components whilst production of the transmission units will be undertaken by NRAO utilizing a design recently developed for the NRAO Very Large Array (VLA) in Socorro. The new design makes use of a new integrated circuit which will increase reliability compared to the discrete component design.

Work is also continuing on all other aspects of the ALMA project, including the Local Oscillator, the correlator, etc. Software development continued according to schedule. ESO participated fully in the System Engineering activity, including the planning of the prototype integration and of the Chilean integration, as well as the project rebaselining.

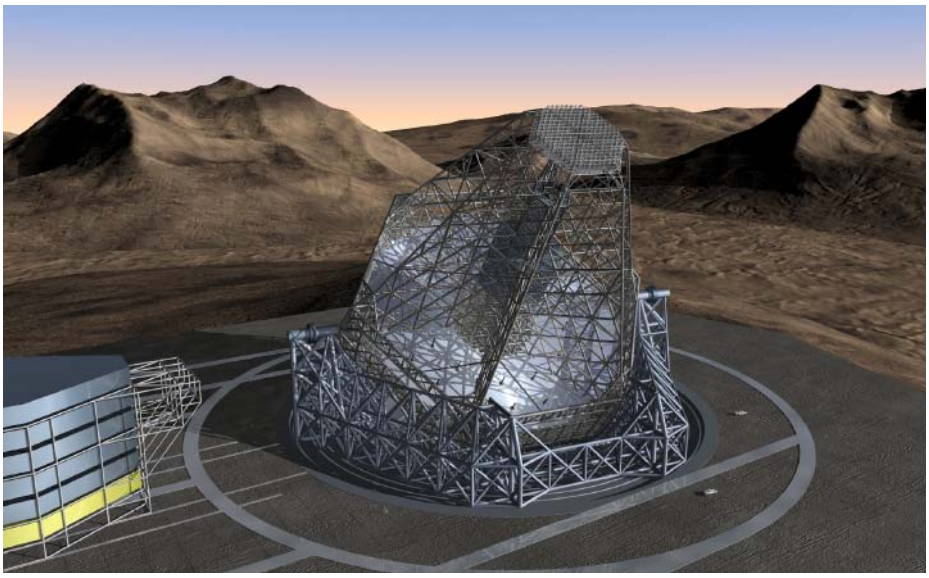
APEX – The Pathfinder

Under ESO's responsibility, the infrastructure of APEX – the Atacama Pathfinder Experiment – was completed and the commissioning of the antenna advanced significantly this year, albeit with many problems. APEX is a collaboration between ESO, the Max-Planck-Institut für Radioastronomie and the Astronomical Institute at the University of Bochum in Germany, and the Onsala Space Observatory in Sweden. As it name suggests, APEX will serve as a pathfinder for ALMA by performing wide-field observations for later ALMA follow-up studies.

Photogrammetry and Holography – quite formidable tasks at 5 050m altitude – successfully led to an excellent adjustment of the reflector, and the optical pointing telescope designed and built on La Silla worked flawlessly to produce the (optical) pointing model for the telescope. Unfortunately, besides considerable delays in the arrival of the first scientific instruments, an accidental operation by the Vertex engineers damaged the secondary unit, thus delaying the final commissioning of the telescope to mid-2005. Thus, APEX will not become available to the community before this time.

Extremely Large Telescope

Artist's impression of the OWL observatory.



The OWL concept design report ("the OWL Blue Book"), which describes the results of both the internal and external (including industrial) studies carried out in the past few years, is under preparation and will be reviewed by a panel of international experts in the autumn of 2005.

In the past year the science case has continued to be developed and consolidated both in-house and especially through the ELT science case working group within the OPTICON network. New and more accurate simulations of OWL's performance have led to better feasibility assessments in several cases. A "physics-experiment"-like science case has been developed that would allow the direct measurement of the acceleration of the cosmic expansion independently of models or assumptions (but with very stringent requirements on the stability of the instrumentation used, over many years). The earth-like exo-planets science case has been further developed with new simulations, confirming the need for very large diameters (> 80 m) to be able to obtain spectroscopy within the nearest 100 light years. At the same time, technical requirements deriving from the updated science cases have been incorporated (either in the telescope design or in the requirements for instrument concept studies).

The design of the OWL telescope has continued, with further optimization of the telescope structure leading to slightly lower mass, increased stiffness and higher safety margins with respect to stress and buckling. Alternative designs with Silicon Carbide lightweight segments, lower azimuth structure or reduced diameter (60m) have also been briefly explored.

Because OWL is based on segmented primary and secondary mirrors, it is essential to ensure correct phasing of these. Substantial progress has been made in this area, with input from groups in Italy (Arcetri, pyramid wavefront sensor), Spain (IAC, curvature sensing) and France (LAM, evolution of a Mach-Zehnder interferometer concept), and a fourth technique based on a Shack-Hartmann concept was developed at ESO. A technical instrument (APE, for Active Phasing Experiment) incorporating these techniques is being designed as part of the ELT Design Study (see below). This instrument is essentially a pupil re-imager which includes a segmented mirror and feeds up to four phasing sensors. It will be mounted on a VLT Nasmyth platform to test phasing techniques and, equally if not more important, to integrate into a single system essential non-adaptive wavefront control functions of an Extremely Large Telescope: field stabilisation, phasing, and active optics including active focusing and active centering.

A full characterization of the diffractive properties associated with obscuration and segmentation has been completed, and studies of high-contrast imaging techniques are in progress. As expected, the efficiency of coronographic suppression is much higher than with smaller telescopes, since a given mask angular diameter translates into a much larger diameter in λ/D units. In addition, preliminary simulations using a double-stage coronograph lead to promising results, with a theoretical residual of less than 10–11 at 20 milli-arcseconds from the parent star. Adaptive optics simulations have also been progressing.

A second industrial study for the supply of Silicon Carbide segments has been completed. Assembling processes have been explored and samples are in production. If such assembling is eventually qualified, this second Silicon Carbide technology would become competitive with the first one.

In parallel, glass and glass-ceramic suppliers worldwide are reviewing their capacity and one of them is studying the option of delivering moderately light weighted (50 %) segment blanks, at negligible cost increase with respect to the figures announced in 2002. In addition, it turns out that these suppliers have, in the last two years, built infrastructures and increased their capacity up to a level that would be adequate for the production of OWL segments in six years. This increase in capacity is of course not motivated by the Extremely Large Telescopes market, but by the demand of the micro-electronics industry for large, high quality and stable reflective surfaces.

A segments integration plan has been elaborated, and the implied infrastructure and processes requirements derived. As expected, it appears that segments integration follows virtually the same path as segments maintenance (re-coatings), albeit with a requested yield of only 40 % of the nominal maintenance yield. The peak demand on the maintenance infrastructure occurs in the sixth and final year of segments integration. This plan,

based on the conservative assumption that segments would receive unprotected Aluminium coatings, requires that 5 segments be processed within a single day (10 hours, daytime). Spare segments allow for such operations to be executed without overhead on science time. The highest technology involved is in the 2-m class coating tanks, and in the metrology system embedded into the handling tool, for semi-automatic replacement and coarse phasing of the segments under maintenance. As segments integration starts after most major subsystems have been completed and provisionally accepted on-site, first light may follow rapidly. According to current estimates, science could start within 19 months after the integration of the first segment, with a total collecting area equivalent to that of a 50-m telescope.

The estimated schedule to completion is currently under thorough review. The baseline plan would allow first light five years after construction begin, start of science one year later and completion 11 years after construction start. The critical path to first light is set by the structure, enclosure, and above all the 8-m mirrors of the corrector and the first generation, 2.3-m class adaptive mirror. Options are currently being explored, whereby early financial commitments would allow for a faster schedule. Such commitments would represent roughly 5 % of the total capital investment, and include, most notably, the early purchase of two 8-m blanks, and of competitive final designs of the structure, enclosure, and first generation adaptive unit. A higher cash flow in the early phases of construction would also be necessary.

Several concept studies on OWL instrumentation have begun, in close collaboration with the astronomical community (most of them are carried out outside ESO), to explore the requirements imposed on instruments by the science cases, and the related feasibility issues. Specific instrument-related science cases are also being developed, in close contact with the other science activities described earlier.

ELT Design Study

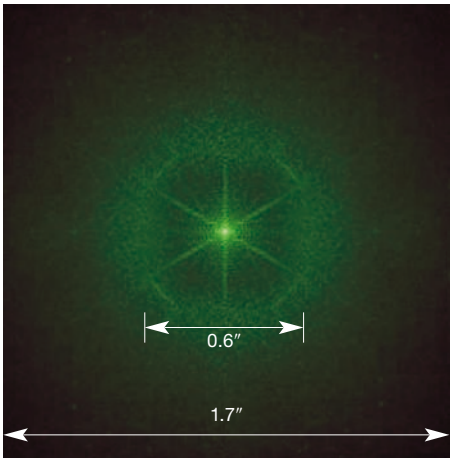
During 2004, substantial effort has been put into the negotiation of the final scope of work and budget for the ELT Design Study. The project, approved for partial funding by the European Commission, covers the development of enabling technologies and concepts for an Extremely Large Telescope, without prejudice to its actual design. As such, the activities covered by this project are complementary with those specifically undertaken for the design of OWL. The design and testing of position actuators, of metrology systems, the development of breadboards for the evaluation of performance under wind excitation, for the on-sky evaluation of wavefront control techniques including phasing (APE), prototyping of thin adaptive shells, site characterization, etc. are typical examples of tasks covered by the ELT Design Study. As parallel, but not redundant activities, the OWL design and the ELT Design Study benefit from mutual feedback, their respective schedules ensure that progress is made in an optimized timeframe, and their complementarities ensure cost-effective developments. Indeed the parallelization of activities is crucial, as delays in the ELT Design Study would potentially delay design and analysis activities with OWL, and vice-versa.

The ELT Design Study gathers 30 partners, mostly European, and including academic as well as industrial resources, under ESO's lead. The proposal was submitted to the EC in March 2004, and received very high marks. The total project cost was estimated at 42 M€, out of which 22 M€ were requested to the EC. It was approved at a level 8.4 M€ in EC funding i.e. 14 M€ lower than initially requested. Utmost effort has been undertaken by most partners in order to cut costs without significant de-scoping, as requested by the EC, and to maintain the level of self funding at the pre-cut values. This included increasing the ESO contribution to 9.4 M€.

OWL Instruments

In support of the on-going OWL Feasibility Study, several Instrument Concept studies have also been started by the Instrumentation division with the astronomical and technical support of institutes in France, Germany, Italy, The Netherlands, Sweden, Switzerland and the United Kingdom. The capabilities being explored include an ultra-stable, high resolution, optical spectrograph to measure the cosmic expansion from the observation of high redshift sources; a wide field camera with partial adaptive optics atmospheric correction for the study of faint stars and galaxies; a multi-object, near IR spectrograph; a small field, diffraction limited planetary camera-spectrograph for the detection of earth-like planets; a sub-millimetre camera for the detection and study of dusty, high redshift star forming galaxies; a thermal infrared camera-spectrograph for the investigation of regions of star formation in the Galaxy and at high redshift, and an instrument for the study of quantum optics phenomena in astrophysics. The specific purpose of these studies is to elaborate on the science goals which are expected to make the largest impact; test the viability of building the required instruments and interfacing them with the telescope; identify any required technical developments and provide a rough idea of possible costs. More generally, this exercise will make the ESO community more familiar with the OWL concept and provide them with the opportunity to contribute actively to its detailed definition and design.

Simulated point spread function in *K*-band, with residual phasing errors, under good seeing conditions, with bright guide star (m_K = 8) and single conjugate adaptive optics (first generation).



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Juan Zagal					
Andres Zarate					

Technical Developments

The Technology Division has contributed engineering and analysis support to over 70 different projects in 2004. About 35 % of these were for telescope systems (including the VLTI), 20 % each for instrumentation projects and ALMA, and the remaining 25 % for Technology Division projects and Paranal maintenance support and upgrades.

Electronic Engineering

Many of the ESO technical standards relate to electronic components and modules. Most of these are commercial products adapted to the VLT software environment, but they also include ESO developments in cases where no suitable commercial unit exists. In all cases, component obsolescence and the continual evolution of technology make it necessary to update or replace standards from time to time.

Following in-house product evaluations, development and testing, the first CAN-bus products have been delivered to projects. As well as providing digital I/O functions, these can also control DC motors. Eventually, stepper motors and other devices will be included. Due to the bus structure of these units, they allow a considerable reduction in cabling in cases where motors and encoders are widely distributed or located at a distance from the VME control processor.

Another development within the Electronic Department is related to finding replacements for the VME analog and digital I/O modules that are required for almost all projects. The commercial units used for the VLT and first generation instruments are now obsolete and it became urgent to find replacements. A search of the market and a programme of in-house testing started in 2003, and a suite of commercially produced modules has now been specified for use in future projects.

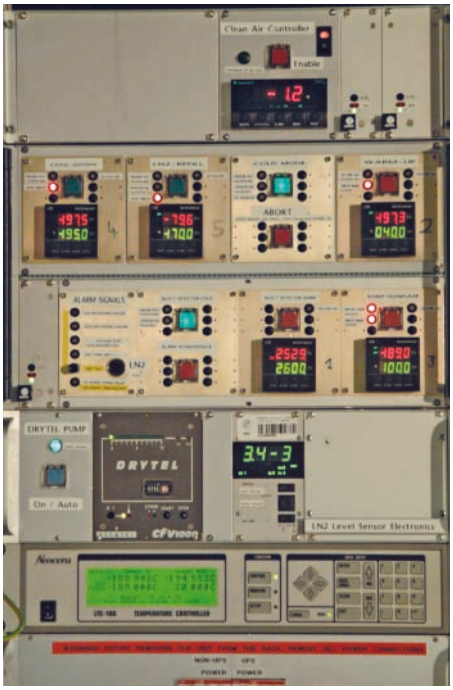
Mechanical Engineering

The Mechanical Systems Department has selected a new 3D-CAD software package to replace *Euclid* that has been used at ESO since the beginning of the VLT era. *Euclid* is no longer competitive with more modern and more powerful CAD systems and it will be retired when current developments using *Euclid* are finished. For new projects, *Catia V* will be used, and a training course for this system for Garching design staff has started. As most existing 2D-drawings are in *AutoCAD* format, this system will continue to be supported to allow modifications and minor developments to be carried out by staff in Chile. As well as 3D and 2D mechanical drawings, modern CAD systems produce many information files, history files, parts lists, etc., which must be archived in a structured manner. A survey is therefore underway to find a suitable Product Data Management (PDM) package to manage and archive this data now that the choice of CAD systems has been made.

Software

Apart from other project work and support for the VLT control software, the Software Department has been engaged in a number of background activities to define and develop new software standards. One key direction has been towards using Linux both as a platform for the VLT workstations and as a development platform for VxWorks real-time software. Up to now, both HP-UX and Solaris have been supported as platforms for the VLT software, but market acceptance and support for these operating systems has been waning over the last few years. Linux is the obvious choice for a future platform, but as the VLT software, after 5 years' operation, is now very stable, any change of platform must be considered with great care and extensively tested. Much of this testing has been carried out on the Garching software control models, but additional testing on the telescopes is also mandatory if any disruption of telescope operation is to be avoided. In 2004, several Linux test runs were carried out on the VLT as well as the smaller telescopes on La Silla. These tests are expected to continue in 2005, leading to formal endorsement of Linux for these applications.

A significant upgrade to the VLT LAN infrastructure concerns the planned adoption of Gigabit Ethernet for fast data transfer. Up to now, ATM has been the accepted standard for LAN backbones. However, the version of ATM currently used is not fast enough to cope with the increasingly large data rates that have to be handled. A particularly challenging requirement for data throughput comes from the VISTA project that anticipates peak data rates of some 54 Mbytes/second and which are beyond the present network capability on Paranal. However, before Gigabit Ethernet can be used, some of the present network equipment such as switches and interfaces, will also have to be updated and plans for this are already starting.



Instrumentation

Preparing SINFONI for the night.

IT Services

A reliable IT infrastructure is essential for almost all aspects of ESO's work. In order to give assurance that the IT support services and infrastructure are adequate for our activities, technically up-to-date and cost effective, ESO commissioned an outside consultancy firm to conduct a study of these aspects. The study, which covered all ESO sites, was completed in mid-2004 and confirmed that the level of the ESO IT infrastructure is, in general, technically good and also cost effective in comparison with other similar organisations. Clearly, there were areas where improvements could be made and these are now being addressed and implemented by the ESO management.

A major change took place in May when the data links between Garching and the sites in Chile were switched over from direct satellite links to an Internet connection. The satellite link has been in service for over 10 years, and has been used for almost all type of communications between sites, including telephone, fax, ftp, email, ERP, and videoconference. As well as being cheaper, the Internet connection allows larger bandwidths and has a much shorter transit time that is important for some applications such as the new ERP system.

Despite the many virus and hacker attacks that occurred world-wide, ESO has escaped rather lightly with only a few minor incidents. This is largely due to the success of the IT security upgrades that were implemented in 2003.

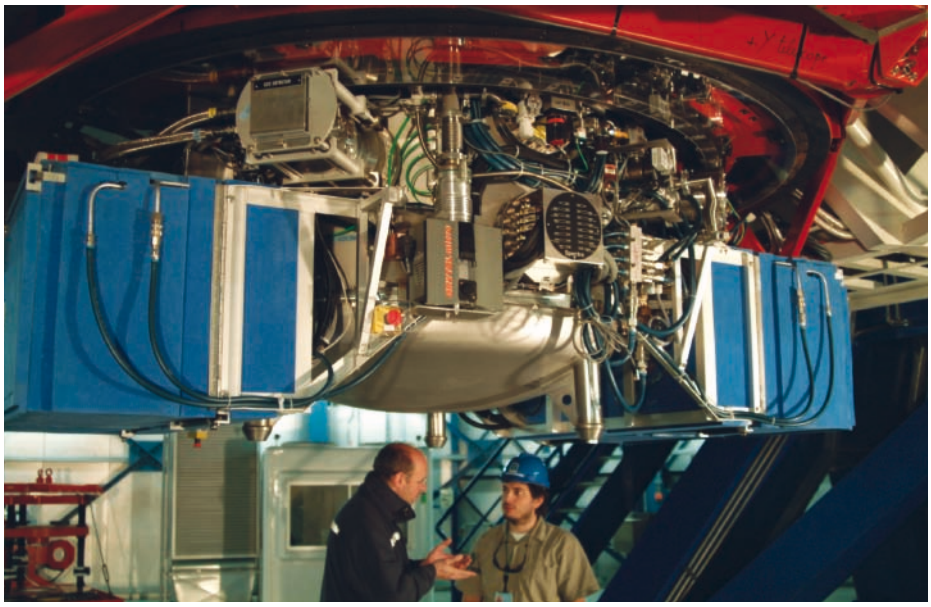
In addition to its normal work, the Garching IT Department has also assisted the ALMA project by setting up the IT infrastructure at the OSF site near San Pedro de Atacama as well as at the Joint Alma Office in Santiago.

Highlights of the year included the successful commissioning and science verification of both the mid-infrared spectro-imager VISIR and the adaptive optics assisted, 3-dimensional, near-infrared spectrometer SINFONI at the VLT. Both instruments will be offered to the community as of April 1, 2005. With then nine regularly operating instruments (not including interferometry) on its four 8-m Unit Telescopes the VLT will offer an enormous range of observing modes and hence scientific capability, to be extended further in the next few years with the arrival of the last of the first generation instruments – the very high resolution infrared spectrometer CRIRES and the wide-field, near-infrared, imager HAWK-I. Some of the existing instruments were also upgraded during the year and, for the more distant future, the already selected second-generation VLT instruments X-Shooter, KMOS and MUSE are in the design phase with a large contribution from many institutes throughout the ESO member states. The two competing Phase A studies for the Planet Finder instrument were also completed in December. All of these projects were presented and well received at the large SPIE conference on Ground-based Astronomical Instrumentation held in Glasgow in June.

VISIR passed its Preliminary Acceptance Europe phase at Saclay near Paris in Spring 2004 and arrived on Paranal towards the end of March. After testing, it was installed at the Cassegrain focus of the VLT Melipal telescope and achieved First Light on April 29. Commissioning was adversely affected by some unusually bad weather on Paranal but was largely completed in three periods up to August since when the instrument has been used for a variety of science verification, advanced guaranteed time, and operational dry run observations in preparation for its use by the general community in 2005.

The SINFONI Adaptive Optics Module was completed at ESO Garching and then installed at the Cassegrain focus of the Yepun telescope in May where its commissioning went extremely smoothly for such a complex system. The SINFONI SPIFFI spectrometer was completed in May at the MPE Garching, including its upgrade with a new camera and 2 k x 2 k infrared array plus associated electronics and software, which was implemented with support from ESO and NOVA. This resulted in a substantial improvement compared with the 1 k x 1 k array used

VISIR on Melipal.



in its stand-alone guest instrument mode in 2003. The full SINFONI was re-assembled in June on Paranal and, again following a fast commissioning period, completed its science verification and operational dry runs ready for use by the general community starting in April 2005. This instrument is the first of its kind on an 8–10 m class telescope and provides a powerful facility for studying very diverse astronomical objects from small solar system bodies to the most distant galaxies.

The sky coverage and hence scientific capabilities of both SINFONI and NACO will be substantially increased once the laser guide star facility is operational at the Yepun telescope. By year's end, the PARSEC laser system developed for this in collaboration with the MPE was fully integrated in Garching and is expected to be sent to Paranal in March 2005.

Related to the study of deformable mirrors needed for the next generation of ELTs, an 18-month long feasibility study has been launched to specifically study the possibility of replacing one of the existing VLT secondary mirrors by such a Large Deformable Mirror. Combined with a sys-tem of four laser guide stars, deployment of such a system would lead to a substantial improvement in the effective seeing over relatively large fields which would enhance the scientific capabilities of HAWK-I, MUSE and probably other existing and planned instruments.

NACO, the infrared adaptive optics assisted imager/spectrometer on Yepun, was upgraded with one of the latest generation of 1 k x 1 k Raytheon 1–5 µm InSb arrays which has substantially increased its sensitivity. It was also equipped with a new prism mode primarily designed for spectroscopic follow-up studies of flares from the direction of the centre of our galaxy which were discovered with this instrument. The VIMOS mechanics was also substantially overhauled and its mechanisms improved and adjusted with a resulting decrease in its technical downtime to around 5–10 %. A new CCD was installed in the "blue arm" of UVES. Two instruments in the assembly, integration and testing (AIT) phase in Europe made good progress. In the case of OmegaCAM, the wide field optical camera destined for the VST survey telescope on Paranal, the camera itself, together with its control and science software, passed its pre-Preliminary Acceptance Europe and the detector system, developed by ESO, achieved First Laboratory Light with all its 32 2 k x 4 k science grade CCD detectors operational.

CRIRES, the high resolution 1–5 µm infrared échelle spectrograph being built by ESO was completely integrated apart from its science detectors and achieved First Laboratory Light on its slit viewing detector. Its specially developed mosaic of 4 1 k x 1 k infrared array detectors was also successfully completed and tested in a special test facility ready for installation in the instrument. With the help of the ST-ECF modelling group, a software model of the spectrograph has also been developed which will be an integral part of the accurate wavelength calibration scheme.

HAWK-I, the last of the VLT first generation instruments, also made excellent progress at ESO Garching. It passed both its Preliminary Design Review in March and its Final Design Review in November and orders for the optics have already been placed. Its FDR was also immediately followed by a Concept Design Review

Laboratory First Light of the ESO-built OmegaCAM detector system which contains 32 2 k x 4 k pixel CCD detectors. Unfortunately the available test source was not large enough to completely illuminate this very large mosaic!

of the additional items (e.g. wavefront sensors) and modifications which would be needed to adapt it for use with the deformable secondary mirror-based adaptive optics system under study and mentioned already above.

An ESO IRACE infrared detector controller capable of handling 256 channels, the largest such system ever built, was completed by the Infrared Detector team in Garching and tested and delivered to the Rutherford Appleton Laboratory in the UK for integration with the infrared camera for the VISTA survey telescope destined for Paranal. A much smaller system was also delivered to the MPE Garching under an agreement to support the GROND instrument at the 2.2-m telescope on La Silla.

View of OmegaCAM.

The first of the selected second-generation VLT instruments, the UV to infrared spectrometer X-Shooter, passed its Preliminary Design Review in December. It is now in its detailed design phase by an extended consortium led by ESO and with institutes in Denmark, France, Italy and The Netherlands which have also, as promised, now secured about 70 % of the capital cost as well as the necessary manpower from national sources.

A competitively selected consortium of British and German institutes also started Preliminary Design work on the KMOS second-generation VLT instrument. Emphasis during the first half of the year was on closing a number of Phase A action items and making a deeper comparative study between the use of robotic arms or beam steering mirrors for selecting objects in the focal plane. The former was finally adopted as the baseline on the grounds that it offers higher sensitivity and flexibility without unacceptably higher cost or risk. The Technical Specification and Statement of Work have been almost finalised for this concept and a development plan, including prototyping of a new design for the critical robot arm, has been produced. Expectations also remain high that the necessary national funding will be secured early in 2005.

Following completion of the Phase A study, the ESO Scientific and Technical Committee recommended continuation of the MUSE second-generation VLT instrument to Council at its June meeting. This is an ambitious integral field optical spectrograph (actually 24 spectrographs) which will completely fill the available space at one of the Nasmyth foci. Again, highest priority for the French-led consortium was given to closing a number of Phase A action items. More recently, a new, all reflecting image slicer has been designed in collaboration with ESO and for which it is planned to procure prototypes from industry with the overall aim of substantially reducing the instrument cost relative to that projected for the Phase A baseline design based on a catadioptric slicer.

Feasibility studies of the proposed second-generation VLT instrument, Planet Finder, were completed by two competing Consortia, one led by MPIA Heidelberg and the other by LAOG Grenoble. Planet Finder is an extremely high-contrast adaptive optics-based system to image the close environment of nearby stars, hopefully down to the detection of giant planets. Following a detailed review of the documentation by the ESO Phase A Board, which included international experts and STC observers, the reviews were completed in mid-December with two, full-day, presentations by the Consortia followed by questions and discussion. After feedback requested from the proponents, the selection process is expected to be completed in the first half of 2005.

The 4-year OPTICON European Commission FP6 programme, which involves 71 European institutes including ESO, was also launched this year. Most of its Joint Research Activities are closely connected to ESO R&D needs for second-generation VLT Instrumentation. This includes the development of next generation adaptive optics components (deformable mirrors, wavefront sensors, Real Time Computer), advanced focal plane smart systems (cryogenic slicers and programmable object pickers) and innovative Volume Phase Holographic Gratings. In parallel, a number of activities on next generation laser guide star emitters are being conducted in collaboration with industrial firms and the Lawrence Berkeley National Lab.

The Astrophysical Virtual Observatory

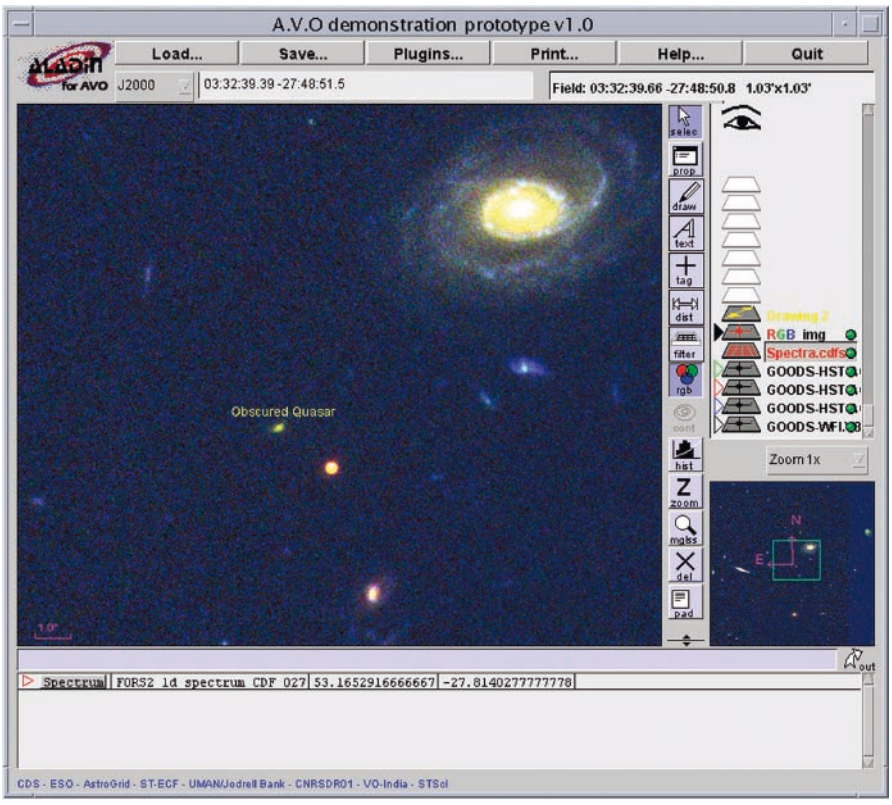
The Virtual Observatory Systems (VOS) Department of the ESO Data Management and Operations Division was created on November 1, 2004. VOS' main role is to manage ESO's involvement in Virtual Observatory activities and to make the Science Archive Facility (SAF) into a power-ful scientific resource for the ESO community. The new department, at present, includes the Virtual Observatory Technology (VOT) and the Advanced Data Products (ADP) groups.

This was the third and last year of the Astrophysical Virtual Observatory (AVO) project. The second AVO science demonstration (AVO First Science) was held on January 27–28 at ESO, concurrent with a meeting of the AVO Science Working Group (SWG). Two science cases were demonstrated: an extragalactic one on Obscured (Type 2) Quasars and a Galactic one on Classification of Young Stellar Objects. The demonstration was a great success and resulted in the publication of the first significant VO refereed paper (Discovery of optically faint obscured quasars with Virtual Observatory tools, Padovani, Allen, Rosati & Walton, 2004, Astronomy & Astrophysics, 424, 545). The acceptance of the paper was accompanied by joint ESO/ESA/ASTROGRID/CDS press releases on May 28. The press release was extremely well received and found its way onto a large number of internet pages, including those of Nature, Science, and New Scientist. The demonstration dealt with a variety of astronomical data at X-ray, infrared, optical, and radio wavelengths, both from space-based and ground-based observatories. It showed the capability of the AVO to do real science, access spectroscopic data, data cubes, and visualization, use new International Virtual Observatory Alliance standards, implement new tools developed based on the science and SWG requirements, access photometric tools, access any VO-compliant data collection and archive, in particular the ESA ISO and XMM-Newton and ESO archives. The last AVO demonstration will be held on January 25–26 2005 at ESAC, Madrid. That will mark the end of the AVO project and the beginning of its successor, the EURO-VO.

The VOT group supported the technical work at ESO for the last AVO demonstration. Moreover, work started on the VOTech project, an FP6, partly EC-funded project which will lay the technical foundations for the Virtual Observatory in Europe.

The ADP group started working out priorities to reach its main goals, namely:
a) creation of advanced, i.e. science grade ("level-3") data products from the ESO archive; b) ingestion of ESO and user-produced ADP into a VO-compliant SAF;
c) publication of ADP within the VO infrastructure.

First Science with the AVO prototype.



Science Archive Operation

The Science Archive Operation (SAO) group is responsible for receiving and redistributing ESO and HST data as well as providing front-line archive user support. Via a Web-based data request submission system, roughly 11 500 ESO and HST requests were serviced this year, representing a 30 % increase over 2004. More than 18 TB of data were distributed as a result of these requests. In addition, over 2 000 CDs and DVDs were prepared for 1 180 Service Mode observing runs, which represent respectively 25 % and 20 % more than last year. Finally, about 250 calibrated VIMOS pre-imaging datasets were produced and issued, always within 48 hours of data acquisition in Chile. This represents 5 times the number of pre-imaging requests in 2003 and approximately 10 TB of data and data products.

The current total archive holding is 32 TB (compressed). Most of these data come from the Wide-Field Imager (WFI) mounted at the La Silla 2.2-m. Roughly 7 TB of new data were archived during 2004, about 15 % more than 2003.

Looking ahead to 2005, SAO anticipates several major operational milestones. Firstly, data from the UKIDDS survey executed with WFCAM at the UKIRT will begin to arrive in March and is expected to have a total annual volume of 4–6 TB until survey completion. Secondly, the ESO archive will be opened to the world-wide community in April 2005, bringing an increase in data requests (currently about 800 per month). Lastly, VST/OmegaCam commissioning is expected to begin by the end of 2005. Once OmegaCam operations are achieved, the expected annual data ingestion rate is expected to be in excess of 30 TB, including raw data and data products.

Looking ahead to the end of the decade, SAO is planning, with other DMD groups, for an expected increase in annual data volume increase of 0.5 TB per year and total archive holdings in the 1 Petabyte (1000 TB) range. Careful planning is needed to make sure that the proper computing infrastructure is in place to deal with such an archive without dramatically increasing the size of the SAO staff.

ST-ECF

ESO and the European Space Agency continue to collaborate through ST-ECF, which provides European support of the Hubble Space Telescope (HST) and other projects of common interest to the two organisations. HST observations approved for the proposal cycle 12 were carried out until June. A total of 921 proposals were submitted for the cycle 13 proposal deadline in January. The share of observing time assigned to European astronomers was 15.7 %. Cycle 13 observations started in July.

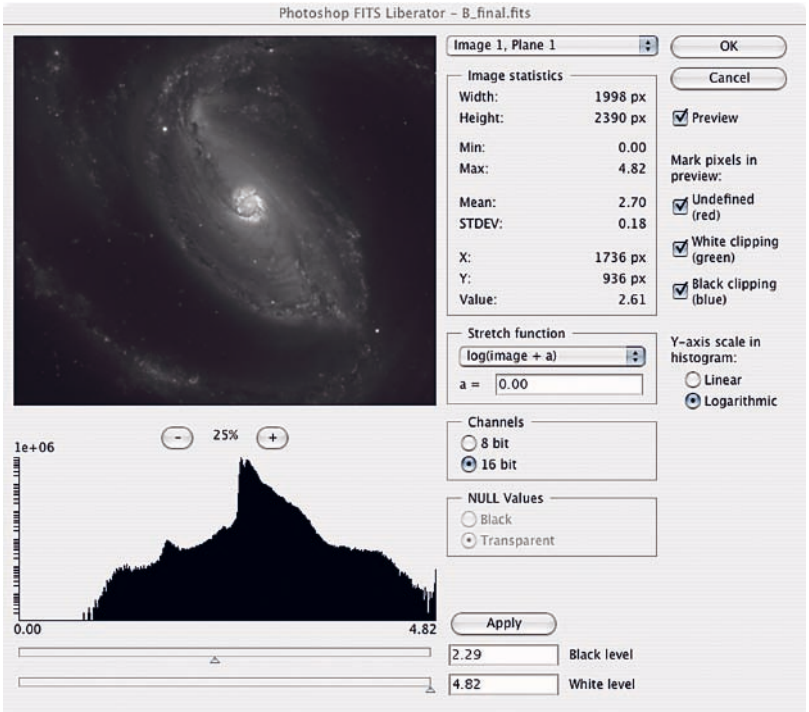
The Hubble Space Telescope started the year with a fully operational complement of instruments and four operational gyros. With the uncertainty surrounding of any future servicing mission, planning continued for operating the telescope in a two-gyro mode. Initial assessment suggests that the impact of the degraded pointing on ST-ECF supported slitless spectroscopy will be small. The Space Telescope Imaging Spectrograph (STIS) suspended operations on 3 August 2004. With the loss of STIS, the slitless spectroscopy modes of the Advanced Camera for Surveys (ACS) and the Near Infrared Camera and Multi-Object Spectrometer (NICMOS) have become the only operating spectroscopic facilities aboard HST. This has resulted in increased interest in these modes, which are supported by the ST-ECF. ST-ECF continues to support the NICMOS and ACS slitless spectroscopy modes. Calibration programmes for both instruments were supported. The ACS extraction software supplied by the ST-ECF, and designed to extract ACS slitless spectra, has been extended to enable combination of dithered slitless spectra using the drizzle software, commonly used for imaging data. The new release, aXe1.4, is capable of extracting the thousands of spectra that are detected on deep ACS Wide Field Camera grism images and also allows the spectra to be browsed through web pages.

One of the main services ST-ECF provides to the HST community is to operate an archive which maintains a full copy of all HST data. A major impact on archive development was the emergence of mature new standards and tools developed by the International Virtual Observatory Alliance.

ST-ECF uses its expertise in instrument modeling and calibration to carry out non-HST projects. Starting in August, the STIS model was ported to the VLT High-Resolution IR Echelle Spectrometer CRIRES model. Laboratory measurements of the refractive indices of the Zn-Se material chosen for the pre-disperser prism of CRIRES yielded the necessary input to study the temperature dependence of the dispersion solution at the anticipated 85 K operational temperature. A generalisation of the model and its tool pack beyond STIS and CRIRES will bring the highly predictive calibration to a much larger field of application in ground and space-based instrumentation.

The ST-ECF supported the work of the "ESA-ESO Working Group on Extra-Solar Planets". This group was established in early 2004 as part of an effort to coordinate long-term planning and activities between ESA and ESO. Chaired by Michael Perryman (ESA) it consisted of seven European astronomers. The group first conducted a survey of the field establishing the status and performance of the various search methods and instruments. This resulted in a detailed picture of the currently existing capabilities. ST-ECF also supported the ESO-based spectroscopic part of the Great Observatories Origins Deep Survey (GOODS). The reduced spectra and the derived redshifts are released to the community through the ESO web page *http://www.eso.org/science/goods/*.

The ST-ECF outreach and education group for the Hubble Space Telescope produced 16 News and Photo releases and 15 Video News Releases in 2004. A special collaboration this year was the Scandinavian CD-ROM & Poster project called *Hubbles Pletskud* that was developed in collaboration with Illustreret Videnskab. The magazine distributed 500 000 copies of the CD-ROM in Scandinavia. The ESA/ESO/NASA Photoshop FITS Liberator plug-in was developed and released free of charge to the public. More than 40 000 copies have been distributed so far. The second version of the Liberator is under development and will be released in April 2005.



Cosmic Ballet or Devil's Mask? Colour composite of the Galaxy Triplet NGC 6769-71 observed with VIMOS on the VLT.

Public Outreach

ESO's public outreach activities comprise communication and media activities, educational projects and targeted events, addressing selected audiences. However, in 2004, one major activity stands out both in terms of visibility and in covering all of the above areas: the Venus Transit 2004 Public Science Discovery Programme. The objective was to use the 2004 Transit as a vehicle for disseminating knowledge about the Solar System, for raising the awareness of method of transit-based observations of exoplanets, to enable the public to re-enact a historical scientific exercise, to raise public appreciation of the scientific method and to collectively obtain a scientific result based on geographically distributed observations.

Organised in collaboration with the Paris Observatory (Institut de Mécanique Céleste et de Calcul des Éphémérides), the Astronomical Institute of the Academy of Sciences of the Czech Republic and the European Association for Astronomy Education (EAAE) and with heavy financial support by the European Commission, it also involved so-called "national nodes" in 25 European countries.

The programme comprised the development of an extensive set of teaching materials for schools, a web-based information and reporting system, observational activities on the day of the transit (8 June) as well as a video contest and a final event held in Paris in November. In the course of the programme, the dedicated VT-2004.org website registered more than 75 million webhits, with 55 million hits occurring on the day of the transit. More than 2 700 observing teams reported their results to the central website. In addition, the site featured a gallery with a total of about 400 childrens' drawings and as many photos. Indeed, the programme developed to become a global activity, with participants from 240 "regions" on all continents. The European Commission found the VT-2004 Programme to be one of the most successful public science discovery programmes carried out in Europe and it was made the subject of a key-note presentation at a major science communication conference in Brussels in early 2005.

Media

In April, the EPR Department organised a meeting between media representatives and the ESO Science Outreach Network. Although the primary purpose was to sensitize the media to the VT-2004 Programme, the meeting provided a very useful forum for discussion of ESO's media policy and practice.

Press release highlights were the 5-year VLT Science Operations, marked by several press releases, a VLT Collection Video Tape, distributed to broadcasters and a DVD with the "Top 20 VLT Science Photos". High-impact news releases described the first discovery of a rocky exoplanet, based on HARPS observations, and the possible first direct image ever of another exoplanet drew a lot of interest and coverage by the media. Further to the

The VT 2004 gallery received about 400 childrens' drawings of this exciting astronomical event.

press release, the discovery of the rocky exoplanet was announced at a major press conference at the EUROSCIENCE Open Forum 2004 Conference in Stockholm, the first attempt in Europe to establish a forum for scientists and journalists similar to the AAAS meetings in the USA.

In total, ESO issued 28 press releases and 13 press photos and provided video news reels and stock video footage to broadcasters amounting to an average of 15 min every day all year round. The press releases are, however, not only seen by journalists. On average – and without counting the VT-2004 site – the Department's website registered 6 000 sessions per day, with a rising trend (36 % up from 2003).

To strengthen its distribution to TV stations, ESO established a collaboration with ESA TV (broadcast through "Europe by Satellite") and – towards the end of the year – with Athena Web, a web-based distribution system for professional broadcasters. ESO video news reels and stock footage are now distributed through these channels.

ESO at JENAM in Granada: Jorge Melnick giving an interview to Spanish TV.

Education

ESO continued its very fruitful collaboration with the EAAE and towards the end of the year published a set of educational information sheets under the title the "ESO/EAAE Journey Across the Solar System". More sheets are planned for publication in 2005. EAAE also played a vital role in the preparation of educational materials in several languages in connection with the VT-2004 programme.

As mentioned in the context of the EIROforum cooperation with the European Commission, ESO took part in the EU Young Scientists' Contest, with a representative on the jury and by sponsoring a main prize, a visit to the observatories in Chile, awarded to nineteen-year old Barbara Burtscher from Switzerland. The Award Ceremony took place, with much media attention, in Dublin in September.

Also in September, ESO brought together a group of educators and experts covering various relevant fields to discuss the development of an ALMA Interdisciplinary Teaching Project, which will enable the introduction of the ALMA project itself in Europe's schools in the coming years.

Events

ESO presented itself with a major information stand at JENAM in Granada, underscoring its commitment to serve and support the European astronomical community and also giving in particular Spanish astronomers an opportunity to familiarize themselves with ESO. It also entertained an information stand at a scientific symposium in Berlin. Furthermore it carried forth the ESO "High-Level Events" with presentations in Sweden (March) and dedicated events for high-tech industrial companies in Spain (April) and Denmark (November).

On September 18, ESO Garching opened its doors to the public as part of the "Long Night of the Stars", an event organised all over Germany, led by the German "Stern" magazine. Around 1 000 visitors visited ESO, listened to popular talks, took part in live video conferences with Paranal and took advantage of the clear night sky to look at a range of celestial objects, thanks to the help and cooperation of AGAPE, the amateur astronomy club at ESO that had kindly made a number of small telescopes available for the event.

Through EIROforum, ESO was represented at information stands at a large science communication conference at the Charlemagne Building in Brussels in May and, as mentioned, at ESOF 2004 in Stockholm in August.

Materials and gifts

Over the year, ESO produced 86 min of movies, including a new film about the ALMA project.

In connection with the five years of science operations with the VLT, commemoration posters were made and sent to Institutes across Europe.

Finally, ESO continued also this year with its annual calendar, which has been extremely well received and has become a much coveted gift item from ESO.

ESO Press Releases

ESO Press Photo 01/04 (7 January): ESO PR Highlights in 2003.
ESO Press Release 01/04 (30 January): First Auxiliary Telescope for the VLT Interferometer Installed at Paranal.
ESO Press Release 02/04 (9 February): Finland to join ESO.
ESO Press Release 03/04 (16 February): Announcing the VT-2004 Public Education Programme.
ESO Press Release 04/04 (1 March): VLT Smashes the Record of the Farthest Known Galaxy – Redshift 10 Galaxy discovered at the Edge of the Dark Ages.
ESO Press Photos 06a-b/04 (2 March): ESO's Telescope Takes Picture of ESA's Rosetta's Target, Comet 67P/Churyumov-Gerasimenko.
ESO Press Release 05/04 (31 March): New Quasar Studies Keep Fundamental Physical Constant Constant – Very Large Telescope sets stringent limit on possible variation of the fine-structure constant over cosmological time.
ESO Press Release 06/04 (1 April): Happy Anniversary, VLT! – Five years at the service of Europe's astronomers.
ESO Press Photos 08a-c/04 (1 April): Titanic Weather Forecasting – New Detailed VLT Images of Saturn's Largest Moon.
ESO Press Release 07/04 (5 April): Adding New Colours to Interferometry – AMBER joins the VLT Interferometer.
ESO Press Release 08/04 (6 April): Milky Way Past Was More Turbulent Than Previously Known – Results of 1001 observing nights shed new light on our Galaxy.
ESO Press Release 09/04 (14 April): A "Dragon" on the Surface of Titan – VLT Looks through Narrow Atmospheric Window and Produces Most Detailed Images Yet.
ESO Press Photo 12/04 (28 April): Cosmic Ballet or Devil's Mask? – Very Large Telescope Witnesses Close Interaction in Galaxy Family.
ESO Press Release 10/04 (5 May): Closer to the Monster – Trailblazing VLT Interferometer Studies of the Central Region in Active Galaxy NGC 1068.
ESO Press Release 11/04 (7 May): Two Extremely Hot Exoplanets Caught in Transit – VLT Measures Properties of New Jupiter-Size Objects in Very Close Orbits.
ESO Press Release 12/04 (12 May): Shadow of a Large Disc Casts New Light on the Formation of High Mass Stars – Massive Star Observed that Forms through a Rotating Accretion Disc.
ESO Press Release 13/04 (12 May): Feeling the Heat – Successful "First Light" for the Mid-Infrared VISIR Instrument on the VLT.
ESO Press Release 14/04 (28 May): Missing Black Holes Driven Out – Astrophysical Virtual Observatory Proves To Be Essential Tool.

ESO Press releases lead to coverage in all media outlets. Shown here is the BBC News Homepage.

Astronomical pictures from ESO routinely find their way to cover pages also of popular science magazines.

ESO Press Release 15/04 (3 June): Charting the Giants – Largest Census Of X-Ray Galaxy Clusters Provides New Constraints on Dark Matter.
ESO Press Release 16/04 (15 June): Weighing Ultra-Cool Stars – Large Ground-Based Telescopes and Hubble Team-Up to Perform First Direct Brown Dwarf Mass Measurement.
ESO Press Photo 20/04 (30 June): Revisiting the Orion Nebula – Wide Field Imager Provides New View of a Stellar Nursery.
ESO Press Release 17/04 (7 July): Old Galaxies in the Young Universe – Very Large Telescope Unravels New Population of Very Old Massive Galaxies.
ESO Press Release 18/04 (7 July): Finland Becomes Eleventh ESO Member State.
ESO Press Release 19/04 (30 July): Catching a Falling Star – ESO's Very Large Telescope Obtains Unique Spectrum of a Meteor.
ESO Press Release 20/04 (17 August): How Old is the Milky Way? – VLT Observations of Beryllium in Two Old Stars Clock the Beginnings.
ESO Press Release 21/04 (24 August): SINFONI Opens with Upbeat Chords – First Observations with New VLT Instrument Hold Great Promise.
ESO Press Release 22/04 (25 August): Fourteen Times the Earth – ESO HARPS Instrument Discovers Smallest Ever Extra-Solar Planet.
ESO Press Release 23/04 (10 September): Is This Speck of Light an Exoplanet? – VLT Images and Spectra of Intriguing Object near Young Brown Dwarf.
ESO Press Photo 27/04 (14 September): The Milky Way above La Silla.
ESO Press Photos 28a-e/04 (29 September): ESO Views of Earth-Approaching Asteroid Toutatis.
ESO Press Release 24/04 (22 October): The Virgo Cluster of Galaxies in the Making – VLT Observations of Planetary Nebulae Confirm the Dynamical Youth of Virgo.

ESO Press Release 25/04 (29 October): Measuring Cosmic Distances with Stellar Heart Beats – VLTI Watches the Changing Size of Bright Southern Cepheids.
ESO Press Release 26/04 (2 November): Summing Up the Unique Venus Transit 2004 (VT-2004) Programme – Vast Public Education Project is an Outstanding Success.
ESO Press Photos 31a-c/04 (18 November): Big Stellar Clusters Forming in the Blue Dwarf Galaxy NGC 5253.
ESO Press Release 27/04 (24 November): Young Stars Poised for Production of Rocky Planets – VLT Interferometer Studies the Inner Region of Circumstellar Discs.
ESO Press Photos 33a-d/04 (1 December): Explosions in Majestic Spiral Beauties – Very Large Telescope Takes Snapshots of Two Grand-Design Spiral Galaxies.
ESO Press Photos 34a-h/04 (10 December): Caught in the Cobweb – Turbulent and Colourful LMC Region Imaged from La Silla.
ESO Press Release 28/04 (21 December): The President and the Galaxy – Chilean Head of State Visits Paranal Observatory.
ESO Press Photo 36/04 (23 December): Season's Greetings!

False-colour composite of M42, the Orion Nebula, obtained with the Wide-Field-Imager (WFI) at the 2,2-m ESO/MPG telescope.

Relations with Chile

One of the priorities of ESO is to contribute to the academic, educational and cultural development in Chile, fostering excellent relationships with its people and government at all levels. Through the year 2004, ESO followed-up on a large number of commitments with the Chilean Government related to the ALMA Environmental Impact Study, geared to protect indigenous population, historical sites and native flora and fauna. Considerable progresses have been obtained on these issues.

As part of the ALMA Agreements signed with the Chilean Scientific Agency, CONICYT, by ESO and its American partner in ALMA, AUI, work progressed very well towards the setting-up of scientific collaboration. In particular, ESO/AUI representatives discussed the establishment of a Committee, chaired by the President of CONICYT, to oversee assignment of funds.

The Joint ALMA Office offices opened in Santiago towards the end of the year and nearly all staff was in place. During the year, the ESO Paranal Observatory welcomed many officials from Chile. The highlight was the very special overnight visit on December 9 to 10, 2004. The President of Chile Ricardo Lagos Escobar and his wife Luisa Durán, arrived to the VLT for the first time and were hosted by the ESO Director General; ESO's representative in Chile, Mr. Daniel Hofstadt; Prof. Maria Teresa Ruiz, head of the astronomy department at the Universidad de Chile; and ESO staff members. The distinguished visitors were shown the various high-tech installations at the observatory, including the interferometric tunnel with the VLTI delay lines and the first auxiliary telescope. Explanations were given by ESO astronomers and engineers and the President, a keen amateur astronomer, gained a good impression of the wide range of exciting research programmes that are carried out with the VLT. President Lagos participated in the imaging of the barred spiral galaxy NGC 1097, located at a distance of about 45 million light-years.

Other distinguished visitors include a delegation from the German Parliament and one from the Belgian Ministry of Foreign Affairs. ESO's Observatories also welcomed many reporters from the European media, in particular from the main European TV channels. The Fifth anniversary of the VLT was the catalyst for several of the TV programmes.

One of the most popular stands at the Interactive Museum in Santiago (MIM) is the new astronomy exhibition developed by ESO in collaboration with MIM. Since the opening on November 12, 2004, this astronomical journey has captured the attention of children and adults with four dynamic videos and a unique space walk through galaxies, nebulae and planets. In 20 minutes, visitors not only learn basic concepts of astronomy such as gravitation, spectroscopy and space-time, but also enjoy some of the most stunning astronomical images collected by ESO telescopes in Chile.

Since 1997 ESO has sponsored the PROED programmes of Planetary Ecology, Helios and Universum, making astronomy more accessible for students and teachers of public schools from the II, III and IV regions in Chile. ESO support has made it possible to train teachers, develop kits of didactic materials, provide access to amateur telescopes, astronomy exhibitions, regional and national workshops on astronomy for schools and the establishment of science-teachers networks. The success of these programmes is based on innovative and participative methods, including experiments in the classroom with the pupils. An example of this is the planetary ecology programme, almost completely financed by ESO for children between 8 and 12 years. There are already 268 trained teachers in 153 schools using this programme to teach students about space, earth, water, air and the ecosystem in an imaginative way.

The Vitacura office was the focus of lively scientific activities, including over 52 colloquia and lunch-talks, eight Joint Astrophysical Seminars, organized jointly by ESO, Universidad de Chile and Universidad Católica, as well as two Chile-wide Topical Meeting on "Accretion onto Compact Objects" and on "Current Supernova Research".

President Ricardo Lagos, ESO Director General, Catherine Cesarsky, and Jason Spyromilio, from the Paranal Observatory.

ESO's Representative in Chile, Daniel Hofstadt (retiring from ESO in March 31, 2005), and MIM Director, Haydée Domic, join Mrs. Luisa Durán de Lagos (in the centre) during the opening of the Astronomy Exhibition.

The Second Advanced Chilean School of Astrophysics: "First Large Scale Structures in the Universe and their Evolution" was organised in Santiago in December, by Pontificia Universidad Católica de Chile with support from ESO. Contacts and collaborations with the Chilean astronomical community are developing very well, through the joint organisation of seminars, schools and workshops, including the support of several post-docs.
The Vitacura office is now also providing increased opportunities for students, from ESO member states in particular, to be trained in Chile during different ESO programmes, whether as a short-term training or as a two year stay in the preparation of their PhD (ESO studentship).
In 2004, 13 students were hosted at ESO/Santiago for a short-term stay while 10 were preparing their PhD. Since 1999, 16 students who came to Santiago on an ESO studentship have successfully defended their PhD and most are now post-docs in various observatories or laboratories.

In preparation of ALMA, the International Astronomical Observatories in Chile organised a conference on the topic of "the Cool Universe". The conference was hosed by the Universidad Tecnica Federico Santa Maria in Valparaiso, the *alma mater* of many technicians and engineers working in astronomical observatories in Chile.

In August, 2004, a seminar on light pollution was held in Antofagasta, with extensive participation of the authorities and the environmental agency, CONAMA. Several mayors from the II Region attended the presentations, as well as representatives of commercial enterprises from the public lighting system sector. The Office for Protection Against Light Pollution, OPCC, (run jointly by ESO, AURA, the Carnegie Institution of Washington and the Chilean Environmental Agency, CONAMA) is currently importing low-pressure sodium lighting equipment to demonstrate the long-term efficiency of its use to the Municipalities.

The Vitacura offices.

European Affairs

As in previous years, ESO's interaction with the institutions of the European Union spans a wide spectrum from project funding to science policy issues. Some activities take place on a bilateral basis, while others take place in the frame of the EIROforum partnership.

Project funding now focuses on the 6th Framework Programme (2002–2006). ESO's participation took place in partnership with a large number of national research institutes. The ELT design study is an example of this: While ESO is coordinating the project, the activities are based on a partnership of 30 European institutes. Thus the guiding principle remains that applications for funding relate to non-core activities and/or are applications in partnerships with national institutes where ESO participation will strengthen both the potential outcome of the project and its chances of leading to a contract.

During 2004, five new proposals were made and, by the end of the year, positive decisions to award a contract were imminent in two cases (ELT and VO-Tech). In the case of the ALMA Enhancement, it was hoped that contract negotiations could be opened in 2005. Two minor proposals were undecided by the end of the year. One EU-funded project was carried out entirely within the calendar year: the highly successful Venus Transit 2004 public outreach programme (described elsewhere in this Annual Report). It should be noted that the competition for FP-6 funds remains intense and that even proposals that achieve very high scores in the evaluation process may nevertheless receive a funding offer from the Commission that is significantly lower than the amount requested – or fail to obtain a contract simply for lack of available funds.

A proposal submitted in October 2003 deserves special mention: the EIROforum Science Teachers' Initiative (ESTI). This project is led by ESA but with strong ESO participation. In January 2004, the European Commission initiated a "clustering process" to merge this project with four other proposals in the same area, unfortunately entailing a reduction of scope for each of the projects. During the year, lengthy and difficult negotiations finally led to an agreement among the potential partners and a contract from the Commission enabling the launch of the twin components of ESTI: the "Science on Stage" European Science Teaching Festival and the European Science Education Journal. The new, combined programme, called NUCLEUS, will include activities in science centres across Europe, innovative teaching activities involving movies and a common web portal, run by EU School-net, the network of 26 ministries of education in Europe. While the "birth" of this new project proved difficult and time-consuming, the clustering process may now open new possibilities for an expanded and extended partnership that goes beyond the scope of the present contract.

ESO continued to interact with the Commission Services in a number of ways, for example, ESO staff participated in preparatory workshops regarding the 7th Framework Programme. As mentioned, ESO staff member participated in the jury for the EU Young Scientists' Contest 2004. Also in the field of science communication, ESO has established excellent links with the Communication Unit of the Commission's DG Research.

ESO's Director General was re-appointed as a member of the European Research Advisory Board (EURAB). EURAB is a high-level, independent advisory committee created by the European Commission to provide advice on European research policy. She also participated in the selection process for the European Young Investigators Awards (EURYI), a scheme to attract outstanding young researchers from anywhere in the world to work in Europe and lead their own research team. The EURYI programme is carried out by the European Heads of Research Councils (EUROHORCs) in cooperation with the European Science Foundation (ESF).

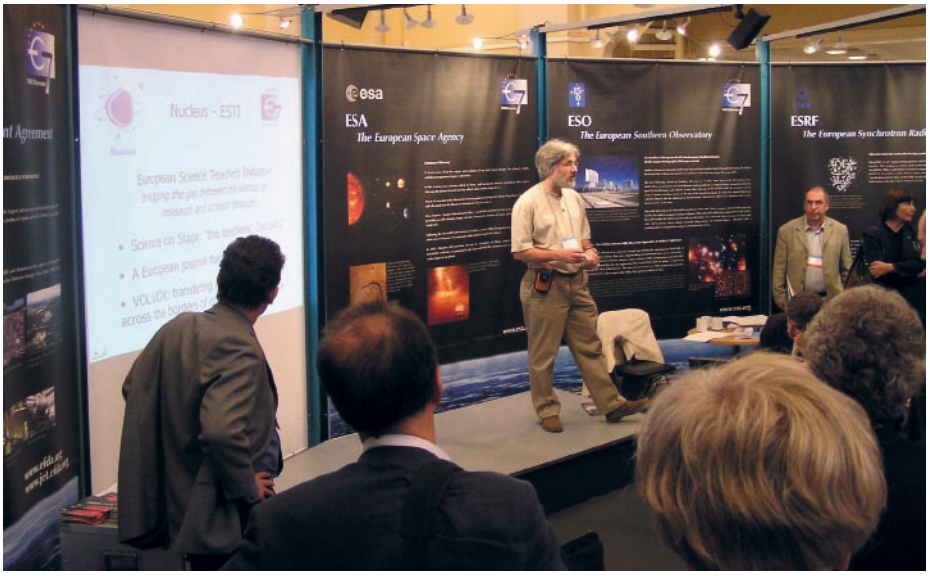
The EIROforum partnership

EIROforum is the partnership of the seven intergovernmental research organisations in Europe which operate major research infrastructures (CERN, EFDA, EMBL, ESA, ESO, ESRF and ILL). It provides a forum for exchange of views among these organisations and a platform for interaction with decision makers within the EU. It also provides a structure for the development of common projects.

EIROforum is a collaboration at the level of the Directors General (or equivalent) of the respective organisations, supported by a standing committee (the Coordination Group) and several thematic working groups. The EIROforum Council (the gathering of the Directors General and the Coordination Group) met on May 4–5 in Culham and on November 23–24 in Brussels. On July 1, ESA took over the one-year chairmanship from EFDA.

The year 2004 was an important year for the EIROforum, marked by the transitional nature of the year as regards science policy matters. Thus, the terms of both the European Commission and the European Parliament expired and following elections in June, the 6th European Parliament convened after the summer holidays. The new Commission was confirmed in November.

In parallel, the preparations for the 7th Framework Programme were underway, following a first Communication by the Commission in June. Important elements of these preparations were proposals to establish a European Research Council in support of competitive science-driven research at the European level and the possibility of a stronger engagement on the part of the Commission regarding the establishment of new research infrastructures. Last, but not least, 2004 was the year when the new Constitutional Treaty was signed. For science, the Treaty contains important clauses. For example, Article I-3.3 lists the "promotion of scientific and technological advance" as one of the objectives for the European Union. Article III-146.1 stipulates that "the Union's action shall aim to strengthen its scientific and technological bases by achieving a European research area."



Presentation of the EIROforum European Science Teachers' Initiative at the EUROSCIENCE Open Forum in Stockholm.

Since the Laeken Convent gathered to prepare the Constitutional Treaty, EIROforum had been involved in this process and we note with satisfaction this outcome which is favourable to science.

Public Interaction

During the year, representatives of the EIROforum organisations, including ESO staff, participated in discussions and gave talks at numerous meetings dealing with a wide range of contemporary science policy issues. Many of the meetings were part of the preparatory process for the 7th Framework Programme, others were of a more general nature.

Thus in March, a meeting was organised by the "Forum Engelberg" in Switzerland under the title "Science on the Agenda of European Politics". On May 11–12, a major conference on Science Communication took place in Brussels, with 500 participants including 120 journalists. A smaller follow-up meeting in November discussed the possibilities for establishing a European Science News Agency.

In August, the EUROSCIENCE Open Forum 2004 took place in Stockholm. The meeting was attended by about 1800 people forming a mix of scientists, media and science policy makers. EIROforum had a major information stand, organised one of scientific sessions as well as a public outreach session featuring video conferencing with our respective research facilities; in ESO's case with the Paranal Observatory.

Cooperation with the European Commission

In late 2003, the Directors General of the EIROforum partner organisations and the European Commissioner for Research signed a "Statement of Intent", creating a framework and identifying areas in which cooperation between the Commission and us might take place.

In the course of 2004, this led to the formulation of a series of concrete proposals covering activities in the fields of human resources, industrial and technological aspects and science and society activities. In most cases, it was proposed to establish joint working groups between the EIROforum and the Commission or set up other mechanisms to facilitate cooperation and, where appropriate, coordination of activities. In other cases, activities could be implemented immediately. For example EIROforum participated in the EU Young Scientists' Contest 2004 with attractive special prizes. The winner of the ESO prize received her award for her contribution "Observations of Comet 153P/Ikeya-Zhang".

The EIROforum Science Policy Paper

At the EIROforum Council meeting in the autumn of 2003, it was decided to put together a major document, in which the Directors General would present their collective views on a range of the most important science policy issues, in particular to provide a perspective for the years to come. The timeframe for the preparation of the document and its publication was set to match the major changes in the European policy scene outlined above.

The preparation of the document constituted a major effort for EIROforum, involving the various working groups and many individuals. ESO played an important part by taking the lead in putting together the paper and, working closely with the EIROforum Chair, to work towards consolidation of an "EIROforum" identity based on a clear vision and constructive ideas for the further development of a truly competitive European Research Area.

The Observing Programmes Committee

The Observing Programmes Committee (OPC) met twice in 2004 in June and in November. For the Observing Period 74 (P74, October 1, 2004 to March 31, 2005), around 762 proposals were received, while for the Observing Period 75 (P75, April 1 to September 30, 2005), this increased to about 828 proposals, in part because two new instruments were offered in P75: VISIR and SINFONI. From all the proposals received, it appears that there is a continuing high demand for the first generation workhorses (FORS1, FORS2, ISAAC and UVES). With the added high demand on FLAMES and on NACO, the pressure factor is now very high on all VLT units. Instruments at La Silla are also still in very high demand, in particular HARPS.

With the aim of taking full advantage of the complementarity of ground-based and space-borne observing facilities, ESA and ESO have agreed to establish an environment for those scientific programmes that require observations with both the XMM-Newton X-ray observatory and the ESO VLT/I telescopes to achieve outstanding and competitive results. During P75, the first period under this agreement, ESO received five proposals out of which three were recommended by the OPC (two of them top ranked). These proposals, were successfully scheduled at both VLT and XMM-Newton telescopes, all of them requiring simultaneous observations at the two observatories. From ESA's side two proposals were recommended time (one being a Large programme) and were successfully scheduled at both observatories.

During 2004 there was a high number of Target of Opportunity (ToO) proposals, in particular in the field of Gamma-ray bursts (GRBs). Twenty-six ToOs were submitted for the Paranal and La Silla telescopes in P74, of which 10 were accepted. For P75 these numbers were 38 and 24 respectively. A large fraction of submitted ToO proposals in P75 were GRB proposals requesting the Rapid Response Mode of the VLT, meaning VLT observations in less than 6 minutes after a trigger. During P75, when the dedicated Gamma-ray burst satellite SWIFT is expected to provide its first reliable triggers, the share of ToO time was exceptionally extended. Moreover, and also exceptionally, some proposals were granted override status over visitor mode programmes to maximize the chances of successful observations of these very time-critical events. Time lost to visitor mode programmes during GRB observations is returned to the programme during service mode. To optimize the scientific return of the recommended GRB programmes ESO invited the successful PIs to an observational strategy meeting in Garching. These meetings will continue in the upcoming periods.

OPC procedures

OPC procedures are working well and there is currently no need for a fundamental revision, although a few items require some consideration. For example, increased attention should be paid to the historical track record of proposals, especially concerning the scientific outcome of the use of ESO facilities, as well as the use of the ESO archive. Also, given the growing number of submitted proposals every Period, the workload on OPC and OPC panel members is reaching a critical level. The OPC selection, structure, and general statistics on time allocation are available to the users via the ESO web.

Large Programmes

"Large Programmes" are projects requiring substantial observing time (more than either 100 hours or 10 nights) for a well-focused scientific goal. The duration is limited to no more than two years (four semesters). Up to 30 % of the total time available for the community may be committed to LPs. In P74 the OPC was faced with 15 Large Programmes (LP),

The Visiting Astronomers' Office (VISAS).

recommended one, and several of the rest were partly converted into normal programmes. In P75, of the 14 proposals submitted three were recommended while some of the rest were partly converted into normal programmes. Between the start of VLT operations in 1999 (P63) and 2004 (P75), 54 LPs were approved by the OPC for Paranal and La Silla telescopes. They cover almost all current astronomical topics, from the Solar System to the study of cosmological parameters.

Public Surveys

Surveys provide large, homogeneous data sets covering a variety of combinations in the parameter space of multi-band, depth and sky area. Often surveys span longer time intervals and have a broader scope than LPs. From their databases, large uniformly treated products can be generated, which can be used for a variety of scientific purposes.

At ESO, surveys have been handled as LPs in recent years. Some of them have been conceived as Public Surveys, such as the various EIS surveys (e.g. Pre-FLAMES, Deep Public Survey, and the GALEX and XMM follow-up surveys), FIRES and GOODS. Others have been handled as proprietary (or private) surveys, such as the *U*-band VIRMOS survey and the SWIRE optical follow-up. Many of these surveys are also connected to legacy-type programmes at satellites and other observatories.

Surveys will constitute an important contribution to the science produced with ESO facilities in the forthcoming era of the dedicated survey telescopes, VST and VISTA. To tackle this “paradigm change” in the best way possible, a new concept for the implementation of Public Surveys was put in place during 2004, allowing Public Surveys to be treated as a separate category to Large Programmes. This new procedure calls for a deeper involvement of the community in the survey production as well as an effective cooperation between the community and ESO to ensure the scientific quality of the products. The first call for ESO Public Surveys took place during November 2004 and a total of 15 ESO Public Survey proposals were received.

The Observing Programmes Committee 2004

Alfonso Aragón Salamanca (Period 74–75)
Paul Crowther (Period 73)
Herwig Dejonghe (Period 73)
Eva Grebel
Martin Groenewegen (Period 74–75)
François Hammer
Vincent Icke (Period 73–74)
Jens Knude
Jari Kotilainen (Period 74–75)
João Lin Yun (Period 73)
Matt Lehnert
Jan Lub (Period 73)
Tommaso Maccacaro (Chairman Period 74–75)
Tom R. Marsh (Period 74–75)
Sabine Moehler (Period 73)
André Moitinho (Period 74–75)
Thierry Montmerle
Göran Östlin
Reynier Peletier (Period 75)
Christian Perrier
Timo Prusti (Period 75)
María Teresa Ruíz
Clive Tadhunter (Period 73)
Leonardo Testi (Period 74)
Stefan Wagner (Chairman Period 73)
Lutz Wisotzki (Period 74–75)

Scheduling

The year 2004 will go down in ESO history as the first year when the schedule of the telescopes was done with a software scheduler. ESO’s new time allocation tool, *TaToo*, is able to produce a high quality and reliable schedule taking into consideration all constraints of the recommended programmes for all telescopes in about 15 minutes. This performance allows schedulers at ESO-VISAS to simulate and evaluate different scenarios, optimize the scheduling of engineering activities at the observatories, and in the end construct the most science efficient schedule possible.

The Scientific Technical Committee

The Scientific Technical Committee 2004

Arnold van Ardenne (NL)
Roland Bacon (F)
Andrea Cimatti (I)
Andreas Eckart (D)
Raffaele Gratton (I)
Paulo J. V. Garcia (P)
Thomas Henning (D)
Richard Hills (UK)
Hans Kjeldsen (D)
Konrad Kuijken (NL)
Simon Lilly (CH)
Dante Minniti (RCH)
Nikolai Piskunov (S)
Jean-Loup Puget (F, Chairman)
Patrick Roche (UK)
Ilkka Tuominen (SF)
Jean-Marie Vreux (B)

The Scientific Technical Committee met three times in 2004: the 57th meeting was held on April 23 and 24 and the 58th meeting was held on October 26 and 27. Moreover, STC met again on December 3 as a continuation of the 58th meeting. All meetings were chaired by Prof. Jean-Loup Puget.

STC 57th meeting

Having heard the report of a dedicated STC/OPC Working Group on Scientific Optimization, the STC endorsed the detailed document "New Procedures for Public Surveys" submitted by ESO, recommending several improvements to the text. In particular, STC emphasized that a team responsible for a Public Survey should commit itself to produce and make publicly available, within a given time, a fully reduced and scientifically usable data set that will be of general use to a broader community of astronomers. The STC also endorsed the two-step procedure, in which a dedicated Public Survey Panel is empowered to negotiate with the survey teams the final design of the surveys, in order to optimize their complementarities.

STC also supported the ESO proposal to make the abstract of the accepted observational proposals public, simultaneously to the public release of the data through the ESO archive. Moreover, following a suggestion by ESO, STC recommended that from now on, teams carrying out Large Programmes should commit themselves to make fully reduced data available via the ESO Archive. For previous Large Programmes, the teams should be encouraged to do so on a voluntary basis.

The STC further discussed the recommendations of the European Science Advisory Committee for ALMA and of the European Alma Board and gave its full support to them. Concerning the creation of "ALMA Regional Centers" (ARC), the STC agreed with the proposal to call for expressions of interest by institutes with strong specific expertise and with the endorsement of their funding agencies. The outcome should be a network of a small number of science support centres, making optimal use of the existing millimetre-wave and aperture-synthesis know-how. ESO should house the centre peforming the "core support tasks" and should act as a coordinator for this network, ensuring that all segments of the ESO community get equal support and that all the software produced by the ARCs are compliant. Financial support by the European Commission should also be sought.

Concerning the VLTI, the STC discussed a proposal to upgrade MIDI by adding a 20 microns mode. STC wondered about the impact of meteorological conditions on Paranal on the efficient exploitation of this mode, and asked this to be quantitatively evaluated before making any recommendation.

STC congratulated the Multi Unit Spectrograph Explorer (MUSE) team for having conducted a complicated Phase A study of the instrument in a very short time. The visible light integral field spectrograph MUSE is part of the second generation of VLT instruments. STC recommended ESO to proceed with the MUSE Team up to Preliminary Design Review, in particular asking for focus on the more challenging aspects, such as mechanical and thermal stability, maintenance procedures, and AO performance for the Narrow Field Mode. STC also suggested that modest descoping options would have to be examined to offer increased reliability and to ensure a timely delivery.

Finally, the STC expressed strong interest in the prospects of implementing an Adaptive Secondary at the VLT and encouraged ESO to move forward with its study. The STC asked for this study report to address also the impact of the Adaptive Secondary on the existing and planned VLT/VLTI instruments.

STC 58th meeting

The 58th meeting of the STC focused again on the VLTI future implementations. The STC was impressed by the high scientific quality of the PRIMA reference mission and acknowledged that the addition of further UT Star Separators was very attractive and recommended accepting external funds for a third (and possibly a fourth) Star Separator. PRIMA (Phase Referenced Imaging and Micro-Arcsecond Imaging), will serve three purposes: one, to increase the sensitivity of the VLTI shifting its limiting magnitude, two, to allow imaging of faint objects with a high angular resolution and three, to access to a high precision astrometry mainly for planet detection. In the PRIMA facility, the star separator system must pick up two stars in a field of view and send them down to the VLTI for detection of their fringe package and stabilisation. The star separator systems are placed directly at the Coudé focus of each telescope.

STC also asked for a full implementation plan of the PRIMA programme to be presented at the next meeting together with a plan for the definition and procurement of second-generation VLTI instruments.

The STC warmly welcomed the ESO proposal to open the ESO Archive to the worldwide community, starting April 1, 2005.

Finally, the STC approved the updated version of the "VLT-VLTI Science Operations Policy" document, recommending to state explicitly that guaranteed time for instrument consortia could also be used as Large Programmes within the rules that regulate them.

The meeting was adjourned to December 3, pending the delivery of the ESO Long Range Plan (LRP). At this last meeting the STC preliminarily confirmed the priorities

The Users' Committee

set by the Council/STC/ESO Working Group on the Scientific Strategy Planning, and found that the overall balance among the major items of the LRP reflected such priorities well. The STC recommended that the "in kind" contributions by new ESO member states should be submitted for scientific evaluation also in comparison with those items that could not be implemented in the LRP at this stage. Still in the frame of the discussion on the LRP, the STC asked to be informed on the ESO-ESA agreement on the future of ST-ECF, and on the ESO-ESA collaboration on issues such as archiving, the Virtual Observatory, and Public Outreach.

Coming to the longer-term future ESO activities, STC endorsed a scenario in which ESO will lead an ambitious ELT project to full completion by 2020. The necessary resources could come from a moderate increase of the member state contributions (10 %) or from other European sources which would allow ESO to built an ELT of intermediate ambition. A more ambitious ELT may instead require the involvement of a major partner sharing nearly half of the cost. The STC agreed that the OWL Phase B study included in the LRP should put ESO in a strong position to negotiate with possible partners, along with the principles already experimented for ALMA. The STC will look forward to the OWL Phase B to be presented at its Autumn 2005 meeting.

Finally, the STC recognized the urgency of expanding the ESO premises in Garching, but was reluctant to recommend prceeding if such expansion was to be achieved within the ordinary ESO budget with the risk of having considerable negative impact on science. Indeed, descoping or postponing adaptive optics projects (such as the development of an Adaptive Secondary) would impact critical items for the future of optical and near-infrared astronomy at ESO. At a time when ESO is building ALMA and preparing for an ELT, STC felt that the concentration of the European segment of ESO in one country has certain advantages, but could not be considered an obligation.

The Users' Committee 2004

Belgium	Hans van Winckel (Chairman)
Denmark	Uffe Gråe Jørgensen
Finland	Heikki Salo
France	Pascale Jablonka
Germany	Sabine Moehler
Italy	Enrico Cappellaro
The Netherlands	Lex Kaper (Vice-Chairman)
Portugal	João Lin Yun
Sweden	Sofia Feltzing
Switzerland	Pierre North
United Kingdom	Malcom Bremer
Chile	Mónica Rubio

The Users' Committee (UC) acts as a direct link between the "users at large" and the ESO officials, and focuses on the broad range of interactions of the current users with the ESO observatories. The aim of the committee is to streamline requests from users and advise the Director General and the ESO staff, with the aim of making the entire process from writing applications for observation time to reduction of the data as efficient and transparent as possible.

In recent years, the ESO observatories and the users' interaction with ESO has changed considerably. The most dramatic change for the general user is no doubt the success of the service observing possibilities. The original goal of reaching an even share between Visitor and Service Mode observations turned out to be untenable and today more than 70 percent of the requested time is in Service Mode. The streamlined rigid data gathering procedures offer the user, even in Service Mode, very efficient tools for their observing strategies. The Data Management Division and the Users' support division are now the main interaction channels for many of the users, more than the staff of the observatories.

Overall, both Paranal and La Silla observatories receive good to excellent satisfaction rates by the users. The evaluation of ESO's telescope and instrument performances by the user is monitored on a daily basis by night reports (for visitors); on a run-basis by end-of-mission reports (visitors) and finally yearly by the UC meeting. It is in the UC meeting that a series of action items (AI) and recommendations are formulated, which are filtered from the general users' requests. Most of these AI and recommendations materialize in concrete results by the next UC meeting, illustrating that the users' requests have significant weight to trigger action by ESO. During this annual spring meeting, the UC handles a full agenda: short briefings on the instrument-telescope performances and proposal handling process; presenting problem reports from the users; discussing new reports on the future of ESO, and a half-a-day focus on a special topic, related to the use of ESO's facilities, and which is covered in much more detail. The special topic of the 2004 UC meeting was the Very Large Telescope Interferometer. Several action items from last year's meeting have resulted in concrete actions already. Others recommendations take longer and will be monitored in the following UC meeting.

Summary of Use of Telescopes by Discipline

The scientific categories referred to in the following tables correspond to the OPC classifications given below:

OPC Categories and Sub-Categories

A: Cosmology
- A1 Surveys of AGNs and high-*z* galaxies
- A2 Identification studies of extragalactic surveys
- A3 Large scale structure and evolution
- A4 Distance scale
- A5 Groups and clusters of galaxies
- A6 Gravitational lensing
- A7 Intervening absorption line systems
- A8 High redshift galaxies (star formation and ISM)

B: Galaxies and Galactic Nuclei
- B1 Morphology and galactic structure
- B2 Stellar populations
- B3 Chemical evolution
- B4 Galaxy dynamics
- B5 Peculiar/interacting galaxies
- B6 Non-thermal processes in galactic nuclei (incl. QSRs, QSOs, blazars, Seyfert galaxies, BALs, radio galaxies, and LINERS)
- B7 Thermal processes in galactic nuclei and starburst galaxies (incl. ultra-luminous IR galaxies, outflows, emission lines, and spectral energy distributions)
- B8 Central supermassive objects
- B9 AGN host galaxies

C: Interstellar Medium, Star Formation and Planetary Systems
- C1 Gas and dust, giant molecular clouds, cool and hot gas, diffuse and translucent clouds
- C2 Chemical processes in the interstellar medium
- C3 Star forming regions, globules, protostars, HII regions
- C4 Pre-main-sequence stars (massive PMS stars, Herbig Ae/Be stars and T Tauri stars)
- C5 Outflows, stellar jets, HH objects
- C6 Main-sequence stars with circumstellar matter, early evolution
- C7 Young binaries, brown dwarfs, exosolar planet searches
- C8 Solar system (planets, comets, small bodies)

D: Stellar Evolution
- D1 Main-sequence stars
- D2 Post-main-sequence stars, giants, supergiants, AGB stars, post-AGB stars
- D3 Pulsating stars and stellar activity
- D4 Mass loss and winds
- D5 Supernovae, pulsars
- D6 Planetary nebulae, nova remnants and supernova remnants
- D7 Pre-white dwarfs and white dwarfs, neutron stars
- D8 Evolved binaries, black-hole candidates, novae, X-ray binaries, CVs
- D9 Gamma-ray and X-ray bursters
- D10 OB associations, open and globular clusters, extragalactic star clusters
- D11 Individual stars in external galaxies

Percentage of Observing Time / Telescope / Instrument / Discipline
La Silla

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
3.6 m	HARPS	1	0	21	14	36
	CES	1	0	1	6	8
	EFOSC2	3	5	9	6	23
	TIMMI2	0	1	24	6	31
	Special-CIGALE[1]	0	2	0	0	2
Total		5	8	55	32	100

[1] Operated from 1 April 2004.

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
NTT	EMMI	9	8	10	11	38
	SUSI2	3	3	9	5	20
	SOFI	6	8	17	11	42
Total		15	21	34	30	100

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
2.2 m	WFI	30	10	11	15	66
	FEROS	0	2	6	26	34
Total		30	12	17	41	100

Percentage of Observing Time / Telescope / Instrument / Discipline
Paranal

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
UT1	ISAAC	14	14	16	12	56
	FORS1[2]	1	3	2	13	19
	FORS2	7	8	2	8	25
Total		22	25	20	30	100

[2] FORS1 was moved on 3 June 2004 from UT2 to UT1.

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
UT2	FORS1[2]	2	4	2	10	18
	UVES	8	3	11	19	41
	FLAMES	6	11	7	17	41
Total		16	18	20	46	100

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
UT3	VIMOS	62	26	7	5	100

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
UT4	NACO	6	23	52	19	100

		Scientific Categories				
Telescope	Instrument	A	B	C	D	Total
VLTI	MIDI	0	9	48	43	100

Council

Two ordinary meetings of Council took place in 2004 at the Headquarters in Garching. In January an extraordinary meeting was held in Garching to finalise the terms of accession for Finland. The Committee of Council met twice during the year, in April in the Hague and in September/October in Rome. All meetings were chaired by Prof. Piet van der Kruit.

At the meeting in June, Council took note of the provisions of the ALMA Agreement with NAOJ (Japan). This Agreement was subsequently approved by written procedure.

On July 7, 2004 Finland became the 11th Member State of ESO.

The Working Group on Weighted Voting, chaired by Dr. Fernando Bello, met four times in Garching. At its meeting in December, Council adopted the resolution on weighted recommendations by the Finance Committee.

The Working Group on Scientific Strategic Planning, which was established by Council in order to offer advice on long term priorities for ESO in the context of a European strategic view of ground-based astronomy, met twice in Garching. Its report was presented to Council in December and the recommendations adopted. At the end of the year, Prof. P. Tim De Zeeuw followed Prof. Ralf Bender as Chairman of the Group, with a revised mandate.

A Negotiating Team was established and met with Spanish representatives in Madrid and Garching to discuss the accession of Spain.

In December, Council set up a Working Group to look at the Terms of Reference of the Finance Committee, which form part of the Financial Rules and Regulations, in connection with the work being done by the Finance Committee Working Group on Financial Rules and Regulations.

Council agreed that the four agreements with the X-Shooter Consortium could be completed and signed, noting that the guaranteed observing time awarded should be within the ceilings as set out in the agreements. Council also authorized the Director General to sign the PRIMA/VLTI Enhancement Agreement.

The ESO Tripartite Group chaired by Dr. Ugo Sessi held two meetings during 2004. Among many issues discussed were the possibility of the pension fund being based on the Euro and the ESO basic salary scale, the issue of contributions to the Health Insurance for retired staff, Long Term Care Insurance, changes to Staff Rules and Regulations regarding travel and temporary transfer to Chile, advancement review, progress in implementation of the ERP system and work of the Life and Work Working Group of the Staff Committee, as well as the Cost-of-Living Adjustment.

Discussions took place on the reports of the Chairpersons of the Finance Committee, the Scientific Technical Committee, Observing Programmes Committee and the Visiting Committee. Council received the regular Instrumentation, VLTI and ALMA reports. The ESO Long Range Plan was discussed in December and will be presented to Council in December 2005 for endorsement.

At the June meeting Council welcomed the new External Auditors from Italy.

One of the major topics of concern throughout the year was the urgent need for a new Headquarters' Building in Garching.

At the ordinary December meeting Prof. Piet C. van der Kruit was reelected President of Council for 2005 and Dr. Fernando Bello was reelected Vice-President. Ms. Rowena Sirey was reappointed Chair of the Finance Committee for 2005.Dr. Tommaso Maccacaro was reappointed Chair of the Observing Programmes Committee for 2005 and Dr. Lutz Wisotzki was appointed Vice-Chairman.

The members of the ALMA Board were reappointed for 2005–2006 (President of Council and Director General (ex officio), Prof. Richard Wade and Prof. Roy Booth). Prof. Piet C. van der Kruit replaced Prof. Richard Wade as Chair of the European ALMA Board from January 1, 2005.

Council and Committee of Council 2004

President	Piet C. van der Kruit
Belgium	Jean-Pierre Swings Monique Desmeth
Denmark	Henning Jørgensen Henrik Grage
Finland	Mirja Arajärvi (until July 2004) Kaveli Mattila (from July 2004) Pentti Pulkkinen (from July 2004)
France	Laurent Vigroux Philippe Barré
Germany	Ralf Bender Andreas Drechsler
Italy	Bruno Marano Vicenzo Dovì
The Netherlands	P. Tim De Zeeuw Jan A. C. van de Donk
Portugal	Teresa Lago Fernando Bello
Sweden	Claes Fransson Finn Karlsson
Switzerland	Michel Mayor Martin Steinacher
United Kingdom	Gerry Gilmore Richard Wade

Finance Committee

Finance Committee met twice in 2004. Both ordinary meetings took place in Garching and were chaired by Ms. Rowena Sirey. The Committee dealt with the usual financial issues, such as annual accounts, budget, cash-flow situation, financial projections and member states' contributions as well as with personnel issues concerning international and local staff. After comprehensive debate, recommendations were made to Council in preparation for the Council decisions.

In the area of procurement, the Finance Committee approved the award of 8 contracts exceeding € 300.000 and 16 single-source procurements exceeding € 150.000. Information was received concerning procurement statistics, forthcoming calls for tenders, price inquiries, etc. It is planned to make advance information on forthcoming Calls for Tenders and Preliminary Inquiries exceeding € 150.000 available on the ESO web pages, Finance Committee welcomed this intention.

The Committee received regular progress reports on the implementation of the ERP system.

The ERP Working Group on Financial Rules and Regulations, which was established in 2003, met once and the subgroup twice, in Garching. All meetings were chaired by Ms. Rowena Sirey. Upon recommendation of the Finance Committee, Council unanimously extended the trial basis of the current Financial Rules to 31 December 2005 or until new Rules are approved by Council, if sooner.

Finance Committee 2004

Chair	Rowena Sirey
Belgium	Alain Heynen
Denmark	Edel Bregnbæk
Finland	Pentti Pulkkinen
France	Patricia Laplaud
Germany	Marlene Lohkamp-Himmighofen
Italy	Ugo Sessi
The Netherlands	Coen J. van Riel
Portugal	Fernando Bello
Sweden	Sofie Björling
Switzerland	Jean-Pierre Ruder
United Kingdom	Colin Vincent

Finance

In compliance with the recommendations set by the International Federation of Accountants regarding International Public Sector Accounting Standards, the ESO financial statements for 2004 are now presented in a standard format comprising: the balance sheet, the statement of income and expenditure and the statement of cash flow.

After 2003, the financial situation of ESO has further improved in 2004, allowing the organisation to present again a positive cash situation at year end for the first time since 1999. The cash and short-term deposits situation per 31 December 2004 amounted to 20.7 M€ (– 5.2 M€ at the end of 2003), reflecting the positive cash flow development during 2004 (+ 25 M€). The net result of the statement of income and expenditure for 2004 was 22.9 M€.

For 2005, the budget was presented in three sections (Income budget, Payment budget, Commitment budget) following the Financial Rules and Internal Financial Regulations adopted by ESO Council in December 2003. The 2005 payment budget (149.8 M€) exceeds the 2005 income budget (139.5 M€) by 10.3 M€.

Financial Statements 2004
(in € 1000)

Balance Sheet	31.12.2004	31.12.2003
Assets		
Cash and short-term deposits	20 742	893
Claims, advances, refundable taxes and other assets	2 669	1 815
Total assets	**23 411**	**2 708**
Liabilities and equity		
Cash and short-term deposits (credit lines)		5 239
Dues, advance payments received and other liabilities	10 434	7 357
Total liabilities	**10 434**	**12 596**
Cumulated result previous years	-9 888	-9 888
2004 Result	22 865	
Total equity	**12 977**	**-9 888**
Total liabilities and equity	**23 411**	**2 708**

Statement of Income and Expenditure	01.01.2004–31.12.2004
Income	
Contributions from member states	109 054
Contributions from third parties and partners	10 200
Income from sales and other income	3 516
Total income	**122 770**
Expenditure	
Expenditure for staff	42 990
Operating and other expenditure	56 915
Total expenditure	**99 905**
2004 Result	**22 865**

Cash flow	01.01.2004–31.12.2004
Cash flow from operating activities	
Receipts	
Income	122 770
Net movements on accounts receivable	-762
Total	**122 008**
Payments	
Expenditure	-99 905
Net movements on accounts payable	2 591
Total	**-97 314**
Net cash flow from operating activities	**24 694**
Cash flow from financing activities	
Net cash flow from financing activities	**394**
Net cash flow = Net increase in cash and short-term deposits	**25 088**

Budget for 2005
(in € 1000)

Income budget	2005
Contributions from member states	105 160
Other income from member states	21 185
Income from third parties	11 193
Various income	1 956
Total income budget	**139 494**

Payment budget	2005
Personnel cost	46 279
Other cost	103 559
Total payment budget	**149 838**

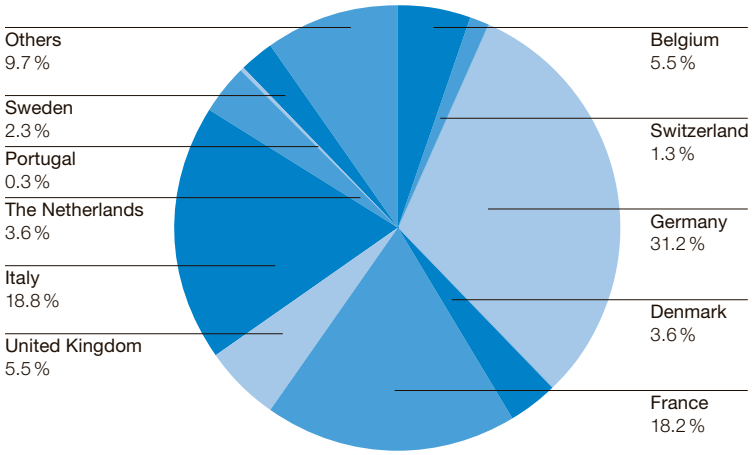
Commitment budget	2005
Personnel cost	46 279
Projects commitments w/o personnel	85 828
Operations commitments w/o personnel	32 888
Total commitment budget	**164 995**

Personnel

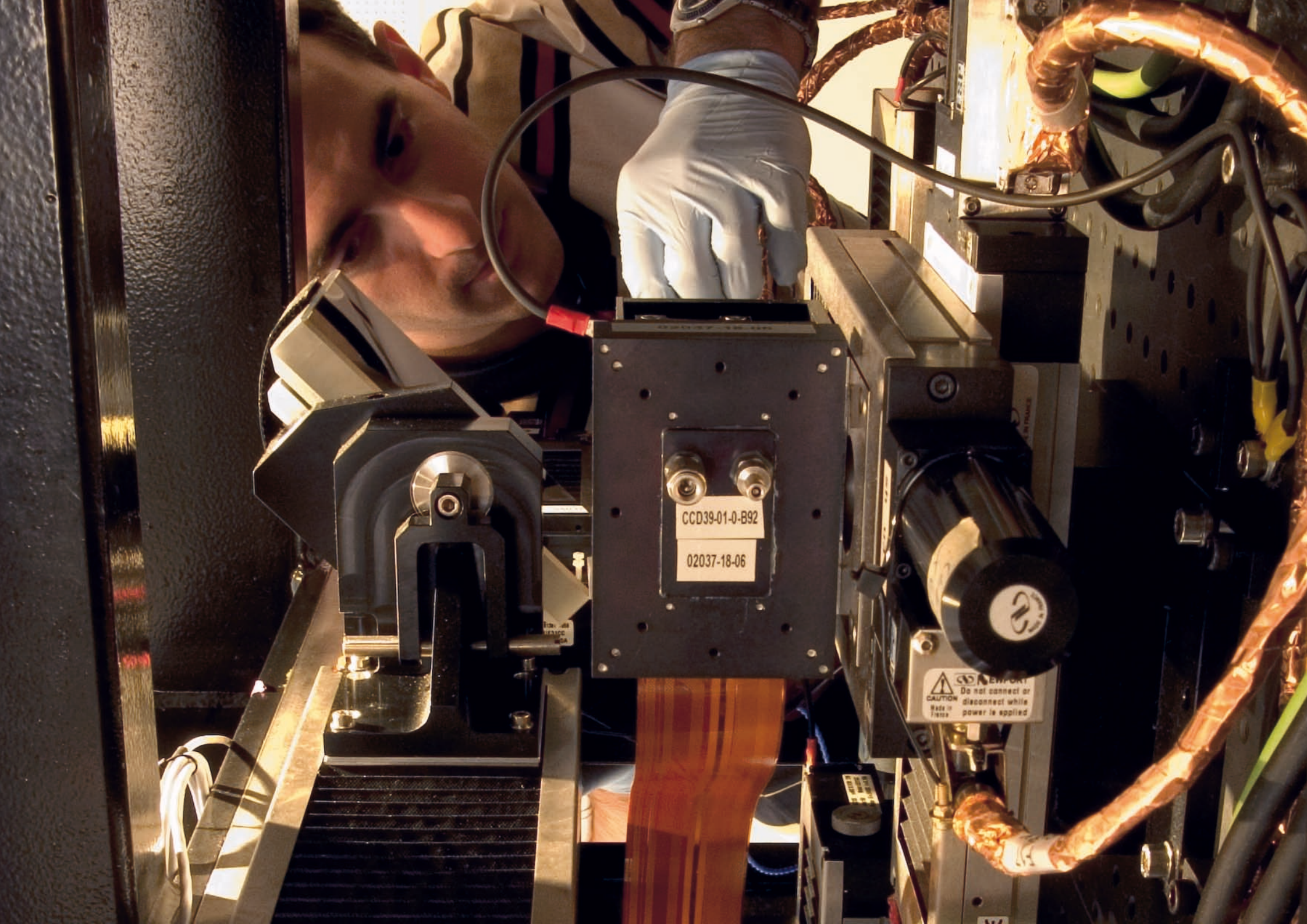
The activities of the Personnel Department Garching/Vitacura and General Services were focused on:

- the operation and further development of the new payroll module within the ERP system;
- the development and implementation of the Travel module of the ERP system;
- the restructuring and process reengineering of the Personnel Department in Vitacura;
- the execution and evaluation of a climate study involving all Local Staff Members and International Staff Members in Chile;
- the development and implementation of the Regulations of the Welfare Fund for Local Staff Members in Chile in close interaction with the Unions of Paranal and La Silla and the Staff Bargaining Commission;
- the collective bargaining and agreement on the employment conditions for Local Staff Members employed for the APEX project in Chile;
- assisting and advising in the process of the merging of the La Silla and Paranal Observatories;
- the agreement and implementation of the modified contribution scheme to the Pension Fund as well as regarding the ESO Health Insurance Scheme and Long Term Care in close interaction with the representative of the International Staff Committee;
- the revision and amendment of the Staff Rules and Regulations and corresponding Administrative Circulars regarding Training, Temporary Transfer, Duty Travel and Overtime;
- the renovation, furnishing and internal removals to new offices on the premises of IPP-Max Planck;
- the outsourcing of technical maintenance services for ESO's Headquarters.

In the course of the year, 16 Local Staff and 28 International Staff Members were recruited. In addition, 143 Students, Fellows, Paid and Unpaid Associates joined ESO. The diagram below shows the International Staff Members of ESO by nationality as of 31 December 2004.



Distribution of International Staff Members by Nationality as of 31 December 2004.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CAUTION
Do not connect or disconnect while power is applied

Four Seasons at a Glance

January

Auxiliary Telescope No. 1 (AT1), the first of four to be installed, arrives at Paranal.

The second Astrophysical Virtual Observatory science demonstration is held at ESO. The first prototype of the Astrophysical Virtual Observatory obtains its first original scientific results, the discovery of a hidden population of Type 2 Quasars.

An extraordinary meeting of ESO Council is held in Garching to finalise the terms of accession for Finland.

February

During a ceremony in Garching, the Finnish Minister of Education and Science, Ms. Tuula Haatainen and the ESO Director General sign an Agreement for the accession of Finland to ESO.

Visit to integration and detector laboratories by a Finnish industry delegation.

In preparation of the Deep Impact Space Mission, an ESO Micro-Workshop is held in Garching, with the aim of coordinating ground-based observations of Comet P9/Tempel 1.

March

Using ISAAC and the magnification effect of a gravitational lens, astronomers have found several faint galaxies believed to be the most remote known. One of them could be a galaxy at the record redshift of 10.

The Astronomical Multiple BEam Recombiner (AMBER) interferometric instrument performs first successful observations.

Preliminary Design Review of the second-generation VLT instrument, HAWK-I, and Phase A review of MUSE.

An ALMA "week" is held near Munich, bringing all ALMA project participants together for an in depth review of the project status.

ALMA Management Advisory Committee meeting in Charlottesville, USA.

High-Level Presentation of ESO in Stockholm, Sweden.

April

"First Light" of the VLT Imager and Spectrometer in the InfraRed (VISIR) instrument on the VLT.

MIDI is offered to the user community.

NACO is updated with a new SDI instrument.

The VLT celebrates five years of Science Operations. On this occasion, a DVD with the "Top 20" astronomical pictures is released as well as a VLT collection tape and a poster.

Meeting with the media in Garching in relation with the Venus Transit 2004 Programme.

Committee of Council meets in The Hague.

ALMA Board meeting in Socorro (New Mexico, USA).

57th Scientific Technical Committee.

ESO Topical Meeting, Vitacura: "Accretion onto Compact Objects"

Dedicated event for high-tech industrial companies in Madrid, Spain, with an emphasis on ALMA.

Signature of the ESO-Finland Agreement.

May

The MIDI instrument on the VLTI obtains unique view of the central part of the nucleus of the active galaxy NGC 1068. This is another world premiere.

EIROforum Council (gathering of the Directors General and the Coordination Group) is held in Culham, UK.

ESO Workshop in Garching: “Planetary Nebulae beyond the Milky Way”.

ESO Topical Meeting, Vitacura: “Current Supernova Research”.

ESO present at the “Exploring the Frontier” symposium in Berlin.

Major Science Communication conference takes place in Brussels, with 500 participants, including 120 journalists. ESO participates in the framework of EIROforum.

June

Transit of Venus! Apart from the unique astronomical event, ESO, with several partners, had set up all year round, with financial support from the European Commission, a major Public Science Discovery Programme. On the day of the transit, the ESO web site recorded 55 millions hits and more than 1.75 TB of data were delivered without falling under the strain.

ALMA Board meeting in Garching.

Council meeting at ESO Garching.

Joint MPA/MPE/ESO/USM workshop on “Growing Black Holes: Accretion in a Cosmological Context” in Garching.

SPIE Astronomical Telescopes and Instrumentation Meeting with many contributions from ESO staff.

ESO participates to the Berlin VW Auto Forum Man & Space Expo which runs throughout the summer.

July

Finland becomes officially 11th ESO Member State.

MACAO #3 is installed on Paranal.

An ESO Summer School takes place in Garching: “The First NEON Archive Observing School”.

August

European astronomers, using the HARPS spectrograph, discover the lightest known exoplanet. Being only 14 times the mass of the Earth, it could quite possibly be a “rocky” planet.

The SINFONI (“Spectrograph for INtegral Field Observation in the Near-Infrared”) instrument has “First Light” on the VLT.

First EUROSCIENCE Open Forum in Stockholm, an attempt in Europe to establish a forum for scientists and journalists similar to the AAAS meetings in the USA. ESO participates extensively in the framework of EIROforum.

Seminar on light pollution was held in Antofagasta, with extensive participation of the authorities and the environmental agency, CONAMA.

ESO participates at the Gothenburg, Sweden, Science Festival.

The ESO AGAPE team shares the viewing of the Venus Transit on the Garching main square.

Installing the mirror in the newly arrived Auxiliary Telescope 2 at Paranal.

Fifth ALMA Heads of Institutes meeting in Garching.

ALMA Community Day in Garching.

Workshop jointly organized by ESO and the Arcetri Observatory: Chemical Abundances and Mixing in Stars in the Milky Way Galaxy and its Satellites.

A group of educators and experts meet in Garching to discuss the development of an ALMA Interdisciplinary Teaching Project.

ESO Garching opens its door to the public as part of the “Long Night of the Stars”, an event organised all over Germany.

Award Ceremony of the EU Young Scientists’ Contest in Dublin. ESO sponsored a main prize.

ESO is present at the JENAM conference in Granada, Spain.

September

An international team of astronomers release what may go down in history as the first direct image of an exoplanet. The five Jupiter mass planet orbits a young brown dwarf in the TW Hydrae Association.

Asteroid Toutatis at closest approach from Earth. Simultaneous observations from La Silla and Paranal allow astronomers to compute accurately its parallax and hence distance.

AT2 is delivered in Europe.

Committee of Council meets in Rome.

An ALMA “week” is held in Charlottesville, USA.

October

58th Scientific Technical Committee is held in Garching.

ALMA Management Advisory Committee meeting in Florence, Italy.

IAOC Workshop on “The Cool Universe: Observing Cosmic Dawn” in Valparaiso, co-sponsored by ESO.

November

“The Venus Transit Experience”, final event of the VT-2004 programme, takes place in the framework of the European Science Week to discuss the public impact of the Venus Transit, the experience gained from this unique pilot project and to prepare the future. The winners of the Video Contest organised on this occasion are also announced.

The stand developed by ESO opens at the Museum Interactivo (MIM) in Santiago.

A dedicated event for high-tech industrial companies takes place in Copenhagen, Denmark. An ESO/Danish agreement on X-shooter is signed.

IRIS Preliminary Acceptance in Europe.

HAWK-I Preliminary Design Review.

ALMA Board meeting at the OSF, San Pedro de Atacama, Chile.

EIROforum Council is held in Brussels.

ESO is present at the Naples Citte della Scienza until end January 2005.

December

Visit of the President of the Republic of Chile, Ricardo Lagos, to Paranal.

AT2 on Paranal summit.

First laboratory light of the OmegaCAM detector mosaic in Garching.

X-shooter Preliminary Design Review.

Council meeting at ESO Garching.

Follow-up of the 58th Scientific Technical Committee in Garching.

Second Advanced Chilean School of Astrophysics, “First Large Scale Structures in the Universe and their Evolution”, is held in Santiago.

ESO releases its 2005 Calendar.

Signing of the X-Shooter agreement at Copenhagen.

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Produced by the Public Affairs Department

ISSN 0531-4496

Back cover photo:
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