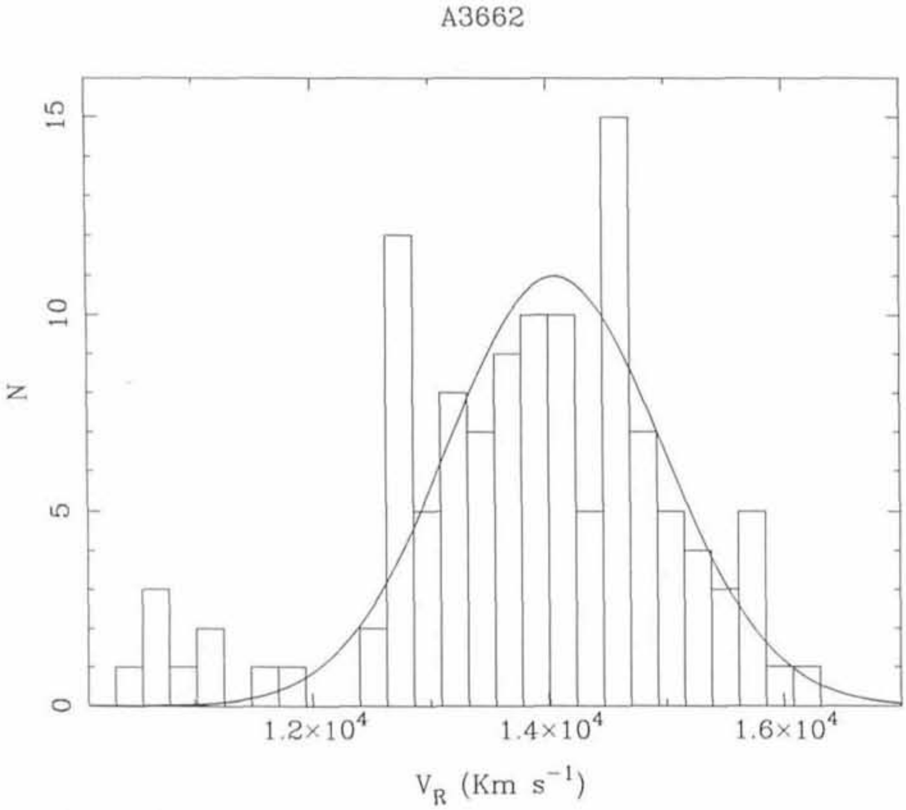

Figure 7: *Distribution of the velocities obtained in one field of the cluster A3662; a gaussian fit is superimposed.*

scriptions (1979); we get a typical value of 40 km/sec as can be seen in Figure 6 in which the histogram of the errors for all the available data is shown. It should be noted that the large scatter is due to a substantial improvement of the error value which decreased from about 60 km/sec for the first runs to about 30 km/sec due to the increased S/N of the last-run spectra. Comparison to external data is under progress. Finally, in Figure 7 we show the distribution of velocities obtained in one field of the cluster A 3662; this is a "structure" cluster, that is a cluster on which we plan to perform detailed dynamical analysis. More data are thus going to be acquired, nevertheless, even from this single field we can suspect the presence of a complex structure (two peaks?). Further data will allow a check on the reality of this feature.

In conclusion, the aim of our project is to give new results both on the structure and dynamics of clusters of galaxies and on their peculiar motions with respect to the Hubble flow. For these reasons we have drawn a composite sample of more than 100 clusters, for which we plan to collect a large bulk of spectroscopic and photometric data. The Optopus multi-fiber instrument is particularly well suited to our aim. It would not have been possible to design such a large project without a large amount of granted telescope time as it is in the philosophy of the ESO Key Programmes.

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A Progress Report on the VLT Instrumentation Plan

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1. The VLT Instrumentation Plan

The Very Large Telescope of the European Southern Observatory is the most ambitious project in the history of ground-based optical-infrared astronomy. With its four 8-m telescopes to be operated as separate units and in a combined mode and the associated array of smaller telescopes for interferometry it represents a unique technical and managerial challenge. Within the overall project, the procurement, installation and operation of a set of instruments at the different foci of the array are in itself an effort much larger than anything done in the past at ESO or at any other observatory. At the same time it is crucial to achieve the scientific goals of the project. For this reason the definition and procurement of the first-generation instruments was tackled very early in the project schedule. In June 1989, ESO elaborated and distributed widely in the community a Preliminary Instrumentation Plan which was based on recommendations by the VLT Working Groups, set up to give advice on the scientific use of the VLT, and technical work carried out at ESO. Based on the responses and comments to this Plan, ESO prepared a revised version which was adopted by the Scientific and Technical Committee in March 1990. This Instrumentation Plan now includes ten instruments and two replicas and a tentative schedule for their implementation at the VLT. Some of the instruments are relatively well defined, for others preparatory work is under way to arrive at a complete set of specifications. A review article on the VLT instruments has been published in the *Journal of Optics* (1991) Vol. **22**, p. 85. Excluded from this plan is the instrumentation to be designed for the VLT Interferometer. Figure 1 shows the mechanical structure of the unit telescope and the foci positions and Table 1 lists the various instruments with their assigned location. The complement of instruments at the first two telescopes can be considered as relatively frozen but the information on the last two telescopes is indicative and might be updated as the project evolves.

A cornerstone of the VLT Instrumentation Plan is the participation of institutes in the ESO member countries in the construction of most of the instruments. This is a major departure from the current situation which sees the quasi-totality of the installed ESO instruments to be the result of internal development. The new approach is dicers (Diffraction Limited and Interferometric Instrumentation), Sandro D'Odorico (Optical Instrumentation) and A. Moorwood (Infrared Instrumentation).

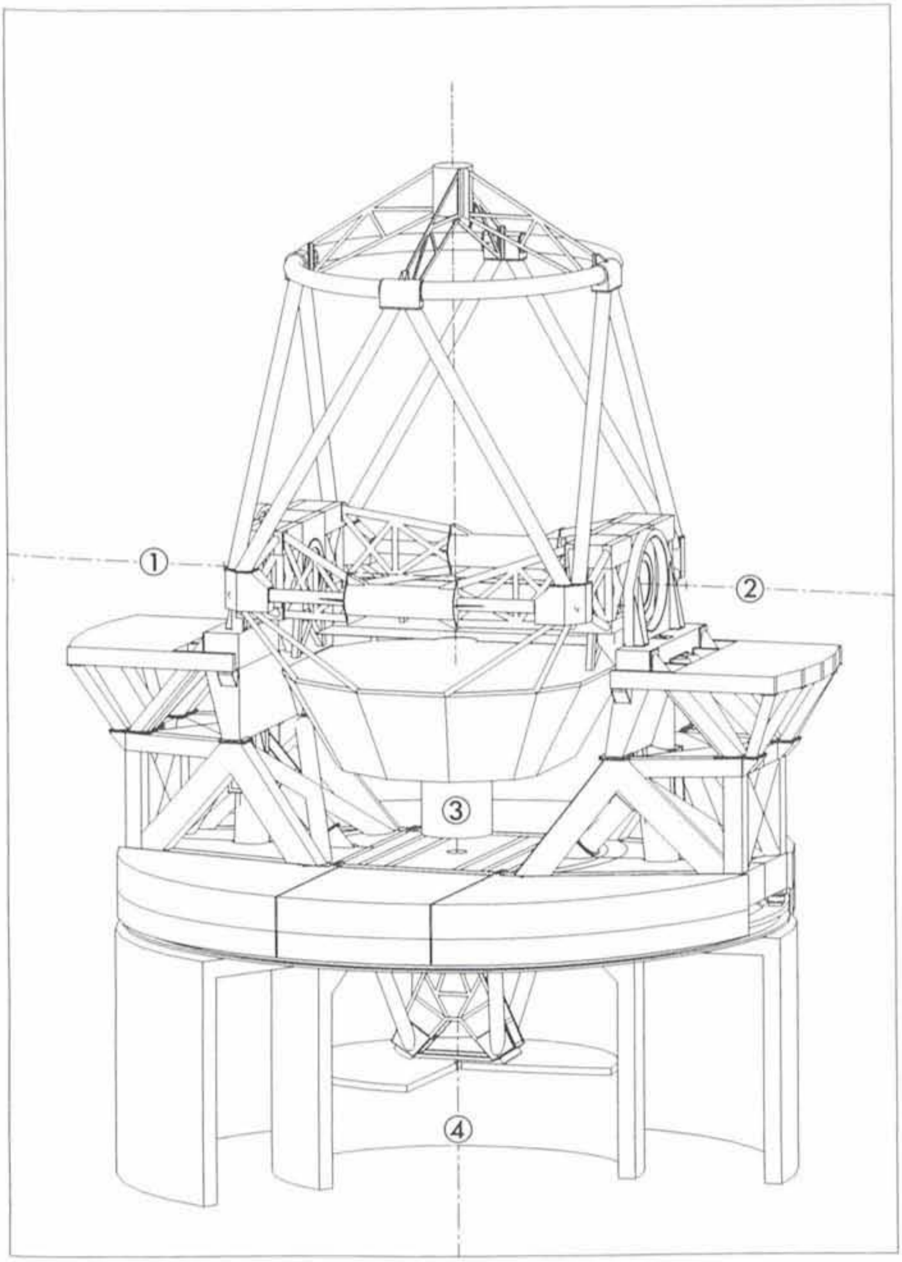

Figure 1: *Tridimensional view of the mechanical structure of the 8-m unit telescope showing the positions of the Nasmyth (1 and 2), Cassegrain (3) and coudé (4) foci.*

tated by the need to fully involve the community in the VLT and at the same time to overcome the limitations on manpower and budget. Only about 10 % of the total VLT financial resources is reserved for instrumentation, even if it is this VLT component which at the end sets the quality and the variety of the scientific results to be obtained by the facility. To use the financial resources in an optimal way, ESO expects to pay for the instrument components to be procured from industry while the institutes will contribute with their expertise, manpower and free use of their facilities. Beside this general guideline, the mechanism of selection of institutes to be associated with the instrument projects is going to be adapted to the characteristics of the single instrument under consideration, such as the degree of definition of the specifications, the amount of expertise in that specific field existing in the community and the time available for the project. Clearly, ESO has to exercise in all cases at tight control on the quality, the costs and the development schedule to make sure that the VLT Instrumentation Plan fully meets its scientific goals and is realized in time and within budget.

In the following paragraphs, we present a short résumé of the status of the different instruments and of the future actions. The VLT Instrumentation effort at ESO is organized by Jacques Beckers (Diffraction Limited and Interferometric Instrumentation), Sandro D'Odorico (Optical Instrumentation) and A. Moorwood (Infrared Instrumentation).

2. Status of the Instrument Projects

2.1 Medium-Resolution IR Spectrometer/Imager

This is one of the two instruments in the Plan to be realized under the direct responsibility of ESO and will be the first major instrument to be installed at the VLT. It will provide for direct imaging at different scales and long slit spectroscopy over the 1-5 μm wavelength range and it is scheduled to be installed at one of the Nasmyth foci of the first unit telescope during the second half of 1996. The Infrared Instrumentation Group is currently finalizing its detailed Technical Specification and a Preliminary Design and Implementation Plan for both internal review and presentation to the Scientific and Technical Committee in November of this year.

2.2 UV-Visual Focal Reducer/Spectrographs

The operation modes of this instrument, to be built in two copies for the Cassegrain foci of the first and the third unit telescope, are similar to those of the two EFOSC instruments in operation at La Silla. Additional features will include a multislit unit and optics for polarimetry observations. A Call for Proposals for the Design, Construction and Installation of the two copies was distributed in May 1990. Two Proposals were received, one from a consortium of the Observatories of Toulouse, Roden and Trieste and the other from a consortium of the Observatories of Heidelberg, Munich and Göttingen. Both proposals being of excellent technical quality, at the end of the reviewing process the German consortium was selected because their offer presents a very significant financial advantage. The contract negotiations are now under way and the project work is planned to start officially in the last quarter of this year. Its schedule calls for an installation of the first copy of the instrument at the UT1 at the end of 1996.

2.3 Near-IR High-Resolution Imaging Camera

This is the first instrument to make use of the individual coudé foci of the VLT and its associated adaptive optics. Its goal is to do diffraction-limited imaging and low-resolution spectroscopy in the 1- to 5-micron wavelength region. It will do that either directly at the longer wavelengths, with or without adaptive optics, or, at the shorter wavelengths, with the aid of image reconstruction algorithms developed in speckle interferometry. The Call for Proposals for this instrument distributed in May 1990 listed only the required capabilities. It left the detailed design up to the proposers. This resulted in two very different proposed instrument realizations, one based on an all-mirror design, the other including lenses. The latter, proposed by a consortium of the Max Planck Institutes for Astronomy (Heidelberg) and Extraterrestrial Physics (Garching) together with the Observatory of Turin was selected after a thorough evaluation. Its schedule calls for installation on the first VLT telescope in 1997.

TABLE 1. ***Complement of Instruments for the VLT***

Medium-Resolution IR Spectrometer/Imager	Nasmyth, UT 1
UV-Visual Focal Reducer/Spectrograph No. 1	Cassegrain, UT 1
Near-IR High-Resolution Imaging Camera	Coudé, UT 1
UV-Visual Echelle Spectrograph No. 1	Nasmyth, UT 2
Visible Speckle Camera	Coudé, UT 2
Mid-IR Imager/Spectrometer	Cassegrain, UT 2
Multi-fibre Area Spectrograph	Nasmyth, UT 3
UV-Visual Focal Reducer/Spectrograph No. 2	Cassegrain, UT 3
UV-Visual Echelle Spectrograph No. 2	Nasmyth, UT 3
Multichannel FTS	Nasmyth, UT 4
High-Resolution/Visible Spectrograph	Combined
High-Resolution/Infrared Echelle Spectrograph	Combined

2.4 UV-Visual Echelle Spectrograph

This is the other instrument to be built under direct responsibility of ESO. At least two identical copies will be built for installation at two Nasmyth foci of two unit telescopes. Based on the concept included in the VLT Instrumentation Plan, the instrument design aims at a very high efficiency and at a maximum resolving power of 40,000. Studies of the various subsystems are now under way with the goal to complete a Predesign Report and an Implementation Plan by April 1992 for internal review and presentation to the Scientific and Technical Committee.

2.5 Multi-Fibre Area Spectrograph

The Focal Reducer/Spectrographs to be built for the Cassegrain foci of the VLT are designed to do multiobject spectroscopy over a field of 7 × 5 arcmin approximately. The Multi-Fibre Spectrograph will be designed to gather and guide the light of objects distributed over the larger field of view of the Nasmyth focus (30 arcminutes diameter approximately) to the slit of a stationary medium-resolution spectrograph. The area spectroscopy option of the same instrument shall be designed to provide spectroscopic data over a 2D array of points covering an area of the sky at a resolution corresponding to the best seeing conditions at the telescope. In the studies which led to the definition of the VLT Instrumentation Plan, the scientific objectives of this type of instrument were not discussed in any detail and hence the technical requirements such as e.g. the number of fibres and the optimal spectroscopic resolution are not defined. To fill this gap, ESO has distributed at the end of July 1991 (see insert on this page) a Call for Proposals for a Definition Study and a Predesign of the instrument. The results of the study will be used for the final specifications of the manufacturing contract.

2.6 Visible Speckle Camera

To reach the highest possible, diffraction-limited resolution of the 8-metre telescopes (0.01 arcsec) it is necessary to use the speckle interferometry techniques at visible wavelengths. These have been largely conceived and developed by scientists in the ESO member countries in the last two decades. These techniques have reached a level of maturity which warrants the implementation of a general-user facility. Although initially planned for a VLT Nasmyth focus, the Visible Speckle Camera is now planned for a coudé focus since the gains in sensitivity resulting from partial wavefront correction by the infrared adaptive optics more than offsets the losses due to the extra reflections. A call for Proposals for a Definition Study of this instrument is to be released later this year.

2.7 Mid-IR Imager/Spectrometer

This instrument is destined for the Cassegrain focus of unit telescope 2 where it will provide for direct imaging and spectroscopy in the 8-14 μm and possibly 20 μm atmospheric windows. Because this is a new but growing area of observational astronomy various options, particularly for the spectroscopic mode, are still being studied and a 10 μm camera with limited spectroscopic capabilities (TIMMI) is also being developed in collaboration with the Service d'Astrophysique in Saclay, France, as part of the VLT Preparatory Programme. ESO is currently planning to issue a Preliminary Enquiry early in 1992 with the aim of establishing which Institutes would be interested in participating in the development of this instrument. Depending on the actual response the intention would then be to place a Phase A study contract with an Institute or Consortium to be followed by a Development Contract based on the Phase A results and any relevant feedback from the TIMMI project obtained in the meantime.

2.8 High-Resolution Spectrographs

The Instrumentation Plan presently includes three high-resolution spectrographs: an optical one to be installed at the combined focus, an infrared Multichannel FTS for a Nasmyth focus and a cryogenic infrared echelle spectrograph again for the combined focus, although it seems difficult to retain both of the latter in the basic instrument complement.

Preliminary studies on possible concepts have been carried out, but both the technical data and the scientific requirements are not sufficiently defined to start action on the procurement. In February 1992 (see *The Messenger*

On July 30, 1991 ESO distributed a "Call for Proposals for a Definition Study and Predesign of the Multifibre Area Spectrograph for one Nasmyth Focus of the VLT" to institutes and individuals with a potential interest to contribute to the study. Deadline for the replies is October 31.

The study contract to be granted will have a duration of one year and a predetermined cost.

Information on this Call can be obtained from:

Mr. Gerd Wieland
Contract Procurement Office
ESO-Garching
Telefax (89) 320 7327

No. 64, p. 59) ESO is organizing a workshop focussed on High-Resolution Spectroscopy with the VLT. We expect that the scientific objectives in this area of research and the different technical concepts will be thoroughly reviewed and discussed, opening the way for a decision later in the year.

3. Upgrading the VLT Instrumentation Plan

By the end of 1992, seven instrument projects (with two of them foreseeing the manufacture of a replica) will be in various stages of development. The remaining three will be in a definition phase. The entire VLT programme will then be far advanced and detailed information will be available on cost, schedule and foreseen performance. The time will then be ripe for a critical review of the entire instrumentation plan, an assessment of the resources still available and decisions on additional instruments.

The VLT Adaptive Optics Programme

From April 24 to May 5, 1991, the current configuration of the COME-ON adaptive optics prototype system for the VLT had its last test run before it returned to Europe for a major upgrade.

This 11-night run was devoted to technical tests for adaptive optics and scientific observations. The COME-ON system worked all the time fully reliably and no technical problems occurred. During the run the seeing conditions ranged from excellent to mediocre, and three nights suffered from bad weather conditions.

The technical part of the programme included tests of improved and new software, observations with partial correction at visible wavelengths, and recording of wavefront sequences.

Software with specialized routines depending on the available photon flux allowed an increase of servo-loop bandwidth from 10 to 25 Hz in connection with the intensified Reticon and the electron-bombarded CCD (EBCCD). With the higher bandwidth and improved modal control scheme the diffraction limit of 0.13 arcsec was reached even in the K-Band under good seeing conditions.

In view of partial correction by adaptive optics for speckle and long baseline interferometry, partially corrected images in the visible wavelength range were recorded with an intensified CCD. These recordings will allow a detailed analysis of the image profiles and verification of theoretical predictions for short- and long-exposure images. For these measurements an optical path was installed parallel to the IR camera.

The recorded wavefront sequences will allow to explore the spatial and temporal behaviour of the turbulence-induced atmosperic perturbations and comparisons with the theory of the turbulence.

The scientific objectives of this run included the environment of young stellar objects, asteroids and planets, the search of the potential third component of Sirius A, and luminous blue variables. From the young stellar objects, S CrA is of particular interest. It shows a clear

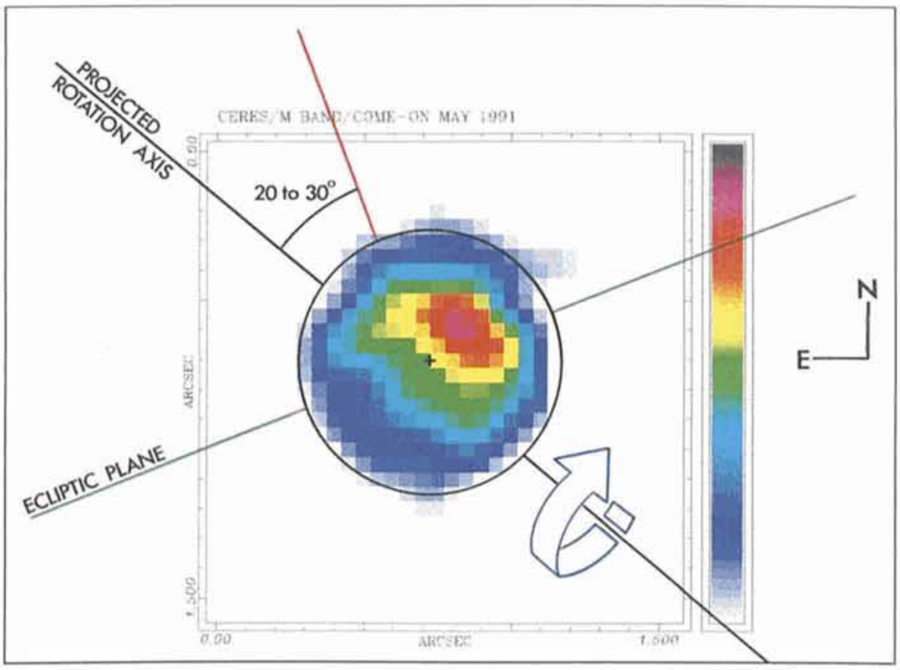

Figure 1: *One of the most impressive results with adaptive optics is the first direct determination of the rotation axis of an asteroid. Ceres was observed on May 5, 1991 with the 3.6-m telescope, using "COME-ON", and a 32×32 IR camera (Meudon). The data are still under reduction. The image shows Ceres at M (4.7 microns). At this wavelength, the reflected solar flux is negligible compared to the thermic emission of the asteroid's surface. Previous speckle observations, confirmed by photometric curves, show that the albedo is constant over the surface. The emission gradient along the S-E/N-W direction is then interpreted as a thermic lag effect of the surface soil, heated by the sun as the asteroid rotates. The rotation axis is found to be inclined 20–30 degrees to the ecliptic pole direction. Courtesy of O. Saint-Pé and M. Combes (Meudon Obs.)*

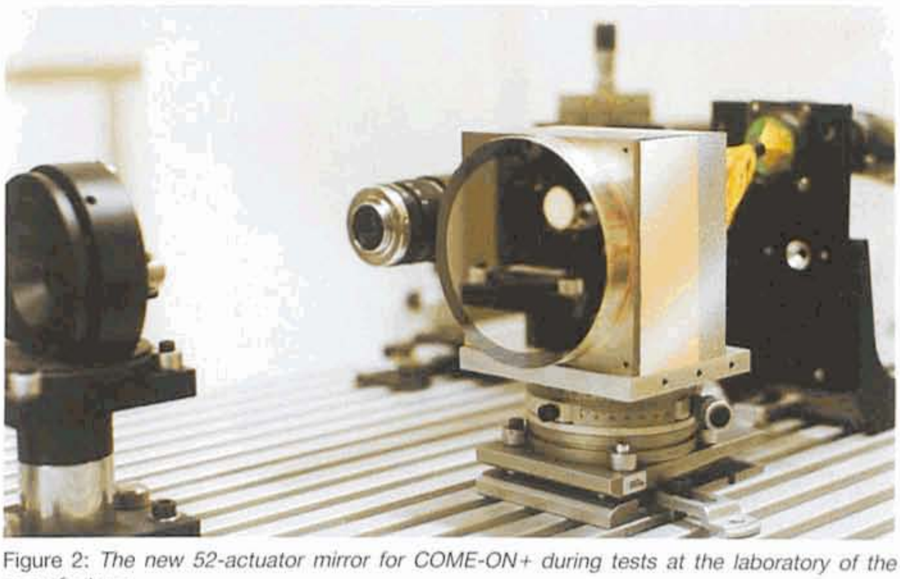

Figure 2: *The new 52-actuator mirror for COME-ON+ during tests at the laboratory of the manufacturer.*