to the great opportunities with modern optical arrays. He specifically stated the unanimous support of the VLTI project by the ESO Scientific and Technical Committee (STC) and was followed by the manager of the VLT project, Prof. M. Tarenghi, who likened the VLTI with an astronomer's dream coming true. Nobody knows for sure which new discoveries will be made with this absolutely unique instrument in the future.

The representatives of ESO's German and French partners spoke about the not so easy task of finding money for such a project in these days of limited ressources, but also how happy they were to bless a truly European undertaking of this dimension. Both Dr. Hasenclever and Dr. Berroir were sure that the new instrument would be of enormous interest to the scientific communities in their respective countries and they were looking forward to the implementation of the new facility at Paranal.

Figure 2: *Discussing the project (from left to right): Prof. H. van der Laan, Director General of ESO; Dr. A. Berroir, Director of CNRS-INSU; Dr. W. Hasenclever, MPG General Secretary, and Prof. M. Tarenghi, VLT Programme Manager.*

Prof. Léna reminded those present of the fact that although the medical science has proven that it is possible to dream a complete dream in just a few seconds, in this case, it has taken European astronomers almost 20 years to realize this particular dream. He congratulated all involved, scientists and engineers, with the excellent preparations, which have finally born fruit. He briefly compared the VLT with other large telescope projects and concluded that it is exactly the great and unique interferometric possibilities which lets ESO's project stand out among the others. As an astronomer, he was looking forward to participate in some of the most important scientific tasks to be undertaken with the VLTI, including the study of proto-planetary systems and the centre of the Milky Way.

The photos from the ceremony were taken by ESO photographer H.-H. Heyer.

The Editor

The VLT Main Structure

M. QUATTRI, ESO

The VLT Programme

During the development of the project the VLT programme was broken down into several subsystems, each of them with clearly identifiable functional requirements and interfaces with the other parts of the project. These subsystems would have lately been contracted to ESO member countries' industrial firms for design and construction. The unit 8-m telescope main structure is one of these subsystems.

The Main Structure

The main structure is a telescope without mirrors and field derotator.

In Figure 1 the items which compose the main structure are indicated. The major components are:

- the telescope steel structure (tube and fork),
- the motors which make it move around the altitude and azimuth axes (drives),
- the angular measurement system which gives the position of the two axes (encoders),
- the supporting system of the telescope (hydrostatic bearings),
- the cooling system used to cool the different power sources placed on the telescope,
- all the equipment which provide safety functions (brakes, locking device to lock the telescope in defined positions for maintenance, emergency stop buttons system),
- the auxiliary systems to monitor the temperature of the steel structure to model the thermal displacements of the attached mirror units,
- the equipment to access the different parts of the structure for maintenance or operations,
- the dummies simulating the inertia characteristics of the mirror units.

The Functional Requirements

Like any instrument of measure, a telescope, once its modes of use are defined according to the scientific needs, must reduce to the minimum acceptable the induced disturbance to the measurements it has to perform.

When the modes of use are different, and imply contradictory requirements, and all of them must be implemented in the same telescope, an accurate evaluation at system level has to be done in order to define the best combination of parameters which characterize the design and which can be clearly specified to a subcontractor, who has to design a part of the complete system without knowing the top level requirements. At the same time, in order to proceed in parallel with the design of the other subsystems, all the interface requirements and boundary conditions have to be defined. This was the job performed at ESO. To derive the functional requirements which would have been specified for the main structure we have started from the following basic requirements:

1. pointing better than 1″
2. tracking better than 0.05″ (both under a wind speed of 18 m/s max. with wind gusts up to 27 m/s)
3. stability of the secondary mirror after chopping of 0.2″ peak to valley with a chopping amplitude of 1′ at 5 Hz and 80 % duty cycle (infrared mode)
4. stability of the Optical Path Distance within 14 nm for an integration time of 10 ms, 50 nm for an integration time of 48 ms and 225 nm for an integration time of 290 ms under a wind speed of 10 m/s (interferometric mode)
5. stability of the position of the altitude and the azimuth axes during the rotation of the telescope
6. stability of the attachment points of the instrumentation during the rotation of the telescope
7. stability of the alignment of the mirror units (primary, secondary and tertiary) within a relative displacement between the mirrors which will not cause a displacement of the image in the Nasmyth focal plane higher than the blind pointing requirement. Because the differential displacement of the mirrors due to the main structure is only one of the contributions to the displacement of the image in the focal plane (others are the deformation inside the mirror units themselves), we required that the contribution of the main structure should not be higher than 0″.3

8. the surfaces of the telescope in contact with the air within ±1 degree C in order to avoid perturbation of the atmosphere surrounding the telescope and consequent seeing deterioration.

Main Structure Specifications

As already described above, the main structure is an electro-mechanical system, and in this sense only electric and mechanical functional requirements, like deflections, eigenfrequencies, weights, wind resistance, motor torque, encoder accuracy, and so on, can be specified and tested on the final product.

The job to derive these parameters kept us busy for quite a long period, during which a large amount of parametric analyses, trade-off among different possible solutions and a lot of conceptual design were carried out.

During this period all the electromechanical parameters to specify the main structure were defined, and at the same time a large number of requirements were imposed to all the other subsystems of the VLT.

Riccardo Giacconi Receives High NASA Honour

Professor Riccardo Giacconi, Director General of ESO since the beginning of this year and before then Director of the Space Telescope Science Institute in Baltimore, U.S.A., has just been awarded the "NASA Distinguished Public Service Medal".

The Director of NASA, Mr. John M. Klineberg, has conveyed his personal congratulations to Prof. Giacconi, informing at the same time that this medal is given only to individuals whose distinguished accomplishments contributed substantially to the NASA mission. Moreover, the contribution must be so extraordinary that other forms of recognition by NASA would be inadequate. It is the highest honour that NASA confers to a non-government individual.

All of us at ESO heartily congratulate Prof. Giacconi to this unique distinction, so rightly deserved through many years of hard work to the benefit of astronomers on all continents. *The Editor*

Since the beginning, and also based on the direct experience we made with the NTT, a few things appeared to be very important to achieve the performance requirements of the VLT:

1. the mechanical structure must be very light, stiff and compact
2. elimination or reduction to the very minimum of all the effects which could have caused disturbance to a smooth motion of the telescope around the axes (for example stepwise motion due to sticking effects coming from the use of ball bearings, or contact between gear-teeth)
3. very good accuracy encoders had to be directly mounted on the axes of the telescope avoiding any gear or friction wheel coupling
4. accurate aerodynamic design of the parts of the main structure exposed to the wind in order to reduce disturbance caused by wind turbulence.

The Preliminary Design

Based on the technical specifications derived as described above, a call for tender was issued to a selected group of companies in the ESO member countries.

After a hard job of selection and analysis of the offers, a consortium of Italian companies was selected. The AES consortium is composed of Ansaldo Componenti (ACO), situated in Genova, European Industrial Engineering (EIE), situated in Venice, and SOIMI, situated in Milan.

On 23 September 1991 the contract was signed. After about 1 year the preliminary design (Figs. 2 and 3) was completed, and the Preliminary Design Review (PDR) was carried out in Venice by an ESO team which included about 15 people to cover all the technical aspects of the project, and two well-known external telescope experts, Pierre Bely of the Space Telescope Institute and Torben Andersen of the Nordic Telescope Group.

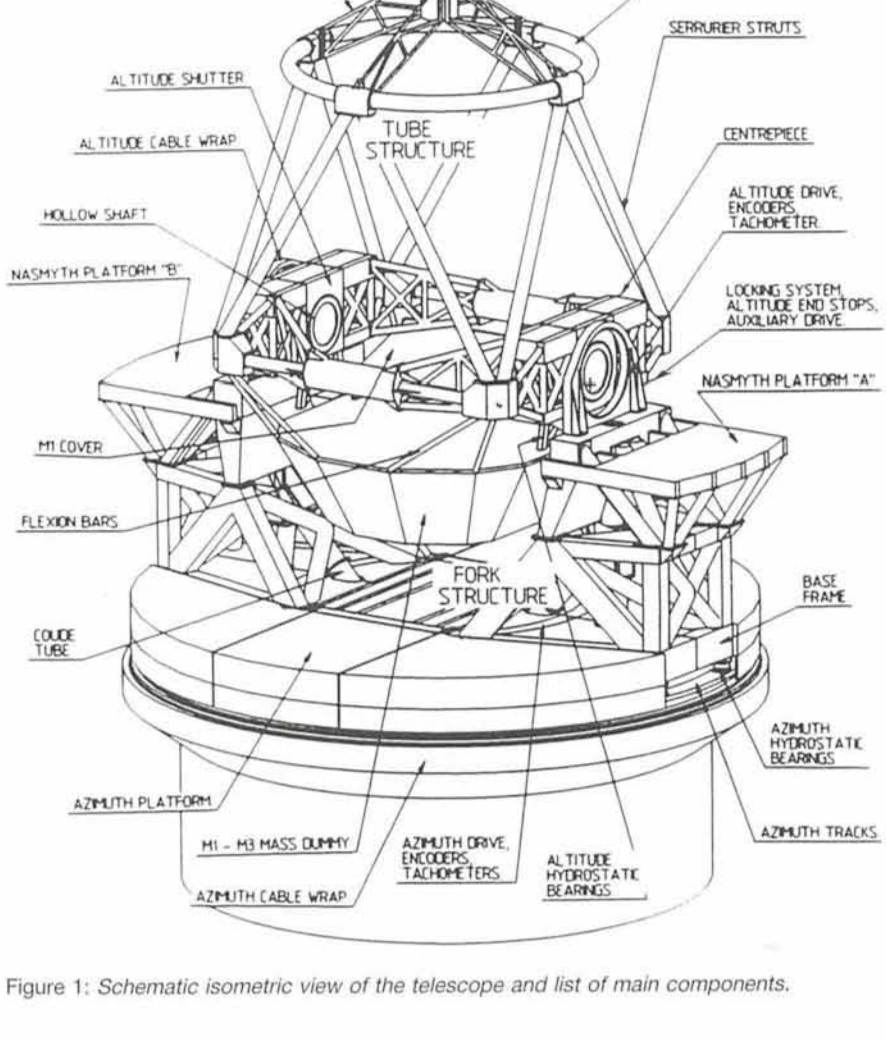

Figure 1: *Schematic isometric view of the telescope and list of main components.*

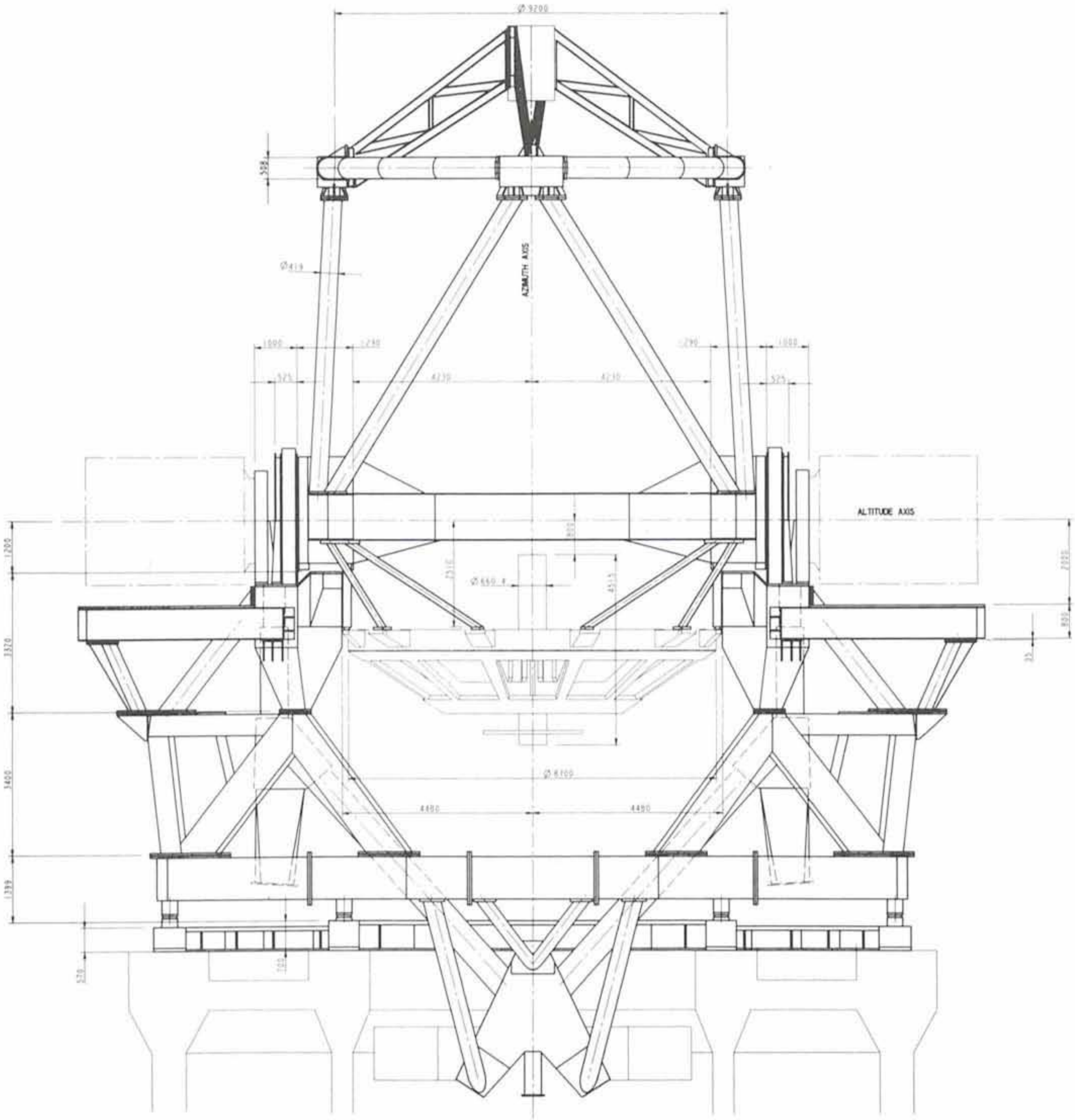

Figure 2: *Front and side view of the preliminary design of the main structure.*

The main features of AES' design are:

1. segmented direct drives on both altitude (about 3 m diameter) and azimuth axes (about 10 m diameter)
2. thrust and centring hydrostatic bearings on both axes
3. double azimuth bearing tracks
4. direct mounted optical encoders on both altitude (about 2.6 m diameter) and azimuth (about 10 m diameter). At the moment both classical graduated steel tape with optical reader heads and laser encoders, based on light phase shift measurement, are being investigated. The aim is to determine which solution fulfills at the best the stringent accuracy requirement of 0.1″ RMS
5. the steel structure makes use of aerodynamically optimized structural profiles, even though some more optimization is needed, and is a trusses structure that realizes the best ratio stiffness/weight for these dimensions of the order of 20 m.
6. the cable wraps are motorized in order not to introduce friction in the telescope,
7. no rotating machinery, like pumps or fans, are installed on the structure, in order to avoid the introduction of vibrations.

The weight of the rotating mass is about 400 t (including the weigths of the mirror units), the lowest eigenfrequency, indicative of the stiffness of the structure, is about 8 Hz. For the sake of comparison, the ESO 3.6-m telescope has a lowest eigenfrequency of 1.4 Hz and weighs about 300 t, the NTT has the lowest eigenfrequency of about 9 Hz and weighs 120 t.

The Next Steps

Since the completion of the PDR the final design phase has been started during which the final optimizations of the design and all the tests needed to validate the adopted solutions will be performed.

At the end a Final Design Review, at the moment foreseen at the end of September 1993, will assess the results of this phase and will give the start to the phase of fabrication.

The first main structure will then be assembled in Milan starting from the end of 1994, and tested for six months by ESO, starting beginning July 1995 till the end of December 1995, with the option to continue till the end of March 1996.

At the same time, after the preliminary acceptance of the first main structure, the second main structure will be erected in Chile, and in April 1996 the provisional acceptance will take place.

Then at the rhythm of one about every 6 months, the other three main structures will be ready for provisional acceptance and for starting the integration of the other VLT subsystems. The last structure will be ready in April 1998.

All Those Who Contributed

A job like the one described above requires the close collaboration of many people with very different competences, and, most of the time, supporting requirements in contrast to each other. Moreover, in the case of the companies involved, most of the time the economical constraints require a large amount of continuous exchange of information without which it would not be possible to achieve any of the results foreseen.

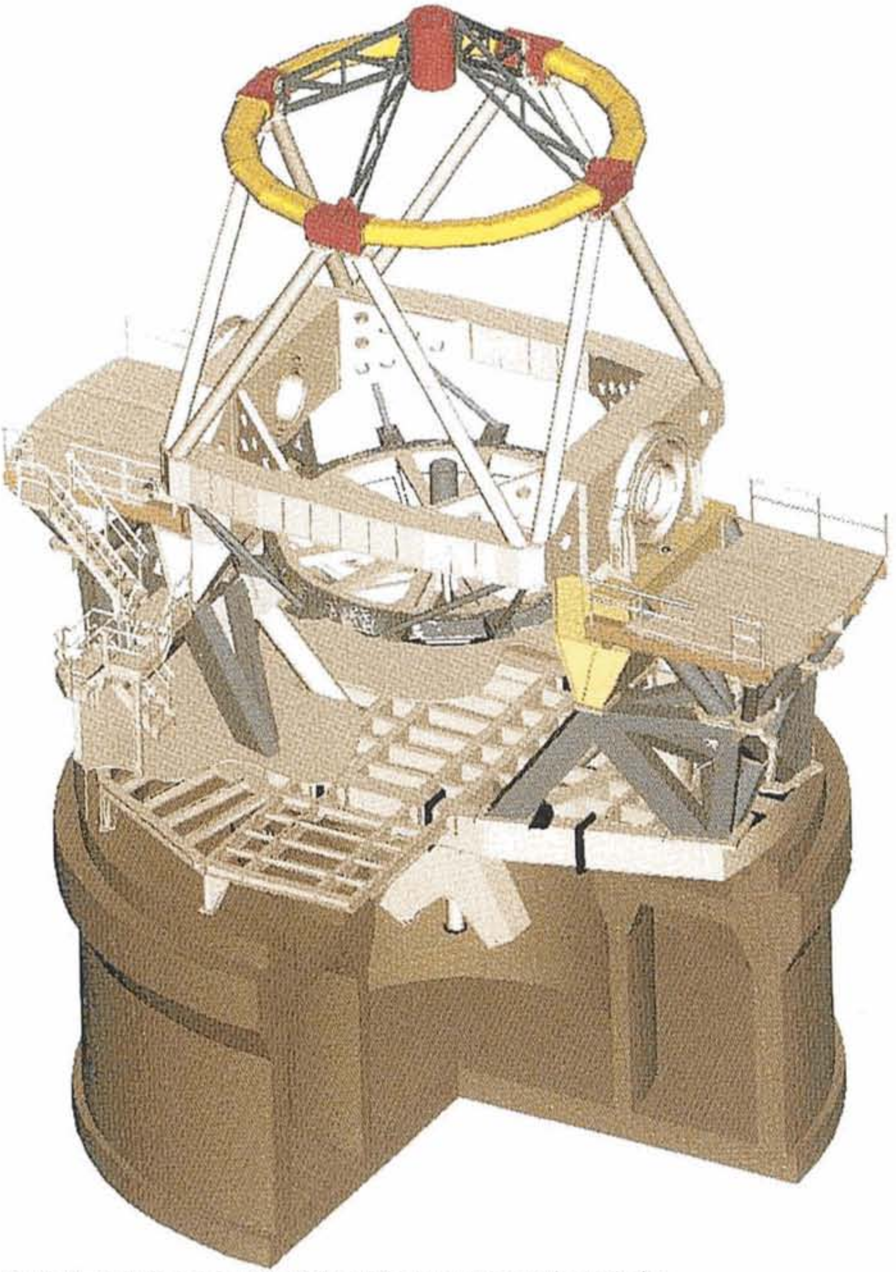

Figure 3: *CAD isometric view of the main structure preliminary design.*

For this reason I would like to mention here all those who have contributed to the definition and design of the main structure: E. Brunetto and M. Kraus, who found solutions to many difficult problems, F. Koch, who supported the definition of many requirements with large and complex F.E.M. calculations, L. Zago, who supported the aerodynamic design, M. Schneermann, who was responsible for the first definition of the basic requirements, M. Ravensbergen, responsible for the electric and control design and tracking performance of the main structure, F. Ploetz, who performed the first assessment of the tracking performance, D. Enard, who has been, since ever, the engineering team leader of the VLT. A special mention deserve the engineering teams of Ansaldo, EIE and SOIMI, who have to struggle daily to design, according to the requirements and within budget, the VLT main structure.

Manufacturing of the 8.2-m Zerodur Blanks for the VLT Primary Mirrors – a Progress Report

P. DIERICKX, ESO

The manufacturing of the Zerodur glass-ceramics blanks for the VLT primary mirrors was contracted by ESO to SCHOTT Glaswerke Mainz in 1988. Since then, spectacular progress has been achieved, and the first blank is due to delivery and transport to the plant of the optical manufacturer [REOSC] by August 1993.

The erection of the VLT blanks production facility in Mainz started on July 6, 1989. Seventeen months later, 45 tons of liquid glass were cast in an 8.6-m mold for the first time. Given the difficulty and size of the problem, this