VLT Main Structure Design

M. QUATTRI, ESO

The main structure of the VLT unit telescope has been completely designed in almost all its details, and performances have been calculated in as much detail as possible, to ease critical paths in the production process. This has meant ordering, and in some cases constructing, some of the components of the structure, such as drives, encoders and the largest mechanical assemblies, before the Final Design Review has been performed.

The Large Mechanical Assemblies

One of the biggest challenges that the Italian consortium AES (Ansaldo Genova, EIE Venice, SOIMI Milan) encountered was to design a system, in spite of the large dimensions and masses involved, with a high first locked rotor eigenfrequency (8 Hz) which will consequently allow a high control loop bandwidth (about 3 Hz according to what Martin Ravensbergen, responsible for the telescope main axis control system, foresees with feasible design).

Beginning of Construction

Left: *This impressive photograph of the Paranal mountain and future VLT site was published in the January issue of the National Geographic Magazine. It was taken by Roger Ressmeyer. The picture clearly shows the location of the four 8-metre telescopes. Also visible is the final stretch of the road designed to facilitate the transport of the 8-metre mirrors from the telescope to the aluminization plant in the Hotel Area, about 3 km from the summit. One can also see the two locations of the seeing monitor, details of which were given in previous issues of "The Messenger", and the meteorological tower which will be part of the astronomical weather station which will serve as an essential complement to the utilization of the VLT. During the current months a consortium comprising the Swedish company Skanska and the Chilean company Belfi will start the final excavation of the remaining part of the site which will house the interferometric complex and tunnel between the unit telescopes. Then they will proceed to pour concrete and initiate construction of the observatory.*

M. TARENGHI, ESO

As a consequence, the disturbance rejection capability of the telescope will be such that the tracking of the telescope under wind buffeting, whose energy content is significant up to about 1 Hz and which is the most important disturbance effect overall, will allow us to reach the accuracy of 0.05″ RMS in autoguiding mode at least 60 % of the nights without the need to use M2 field stabilization, while the accuracy will become 0.03″ RMS in all conditions using M2 field stabilization.

After the Preliminary Design Review carried out in November 1992, the analysis of the dynamic performance of the main structure has been refined in more and more detail. During this process it was discovered that the preliminary design model did not properly take into account the real interaction between the structure, the centring azimuth hydrostatic bearing and the azimuth drive, and that the preliminary model introduced some extra stiffness which had led us to overestimate the first locked rotor eigenfrequency around the altitude axis. After removing the overconstraint, the first locked rotor around altitude resulted in about 6.5 Hz, very far indeed from the value specified by ESO.

Several solutions have been studied since then to increase this eigenfrequency which was dominated by the radial displacement of the centring azimuth hydrostatic bearings, in itself virtually infinitely stiff, causing the deformation of the base frame thus allowing rotation of the fork arm.

The solution was found by AES changing the load introduction pattern in the fork arm. This modification led to a first locked rotor eigenfrequency around the altitude axis of 8.11 Hz.

The lowest natural frequency of the telescope is about 7.2 Hz, but the mode is such that it is neither excited by the drive motion nor by the wind due to the protection provided by the enclosure, and thus will not reduce the disturbance rejection of the main structure.

This achievement of the specified first locked rotor eigenfrequency has closed the activities on the structural design and has started the activities of production of the final drawings for procurement and construction of the large mechanical assemblies. Moreover, this has also validated the design of the azimuth bearings whose tracks have already been built and are being machined in the Ansaldo factory in Genova (Fig. 1).

The Hydrostatic System with Active Centring

The completion of the structural design has brought us to the definition of the boundaries of the centring azimuth bearings.

These are the radial bearings which run around the inner azimuth track and centre the telescope azimuth axis.

The preliminary design of AES foresaw a passive arrangement which made use of the mechanical structure as a spring to allow the accommodation of differential displacement of the base frame of the fork with respect to the inner track due to temperature difference, or to run-out tolerance of the track itself.

A more detailed analysis of the behaviour of the system under the extreme functional temperature range has brought us to rethink the passive solution, due to the danger of possible jamming if the relative displacement caused the maximum allowable load in the pad pockets to be reached.

Now the solution for the centring pads consists of four pairs of pads each controlled by an electrovalve which will maintain the load on the pads constant at about 15 t. This will be done acting on the volume of the pad back-chambers by injecting or letting out oil in a continuous manner.

Even though this system was designed mainly as a safety device it will also be useful to centre the azimuth axis at a better level than the minimum run-out of the track.

The centring bearings were the last open issue concerning the hydrostatic system.

The prototype of the azimuth axial bearing has already been thoroughly tested by Riva Hydroart in Milan (Fig. 2) and has been proved to fulfil the requirements of the VLT main structure. The production of the azimuth axial bearings is already going on and already four pairs of pads for the azimuth axis of one telescope have been prepared for final machining (Fig. 3).

The Drive System

Also the final design of the drive system has been completed. Two segmented motors on the altitude axis of 36 kNm maximum continuous torque each and 2.6 m diameter and one segmented motor on the azimuth axis of 125 kNm maximum continuous torque