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.

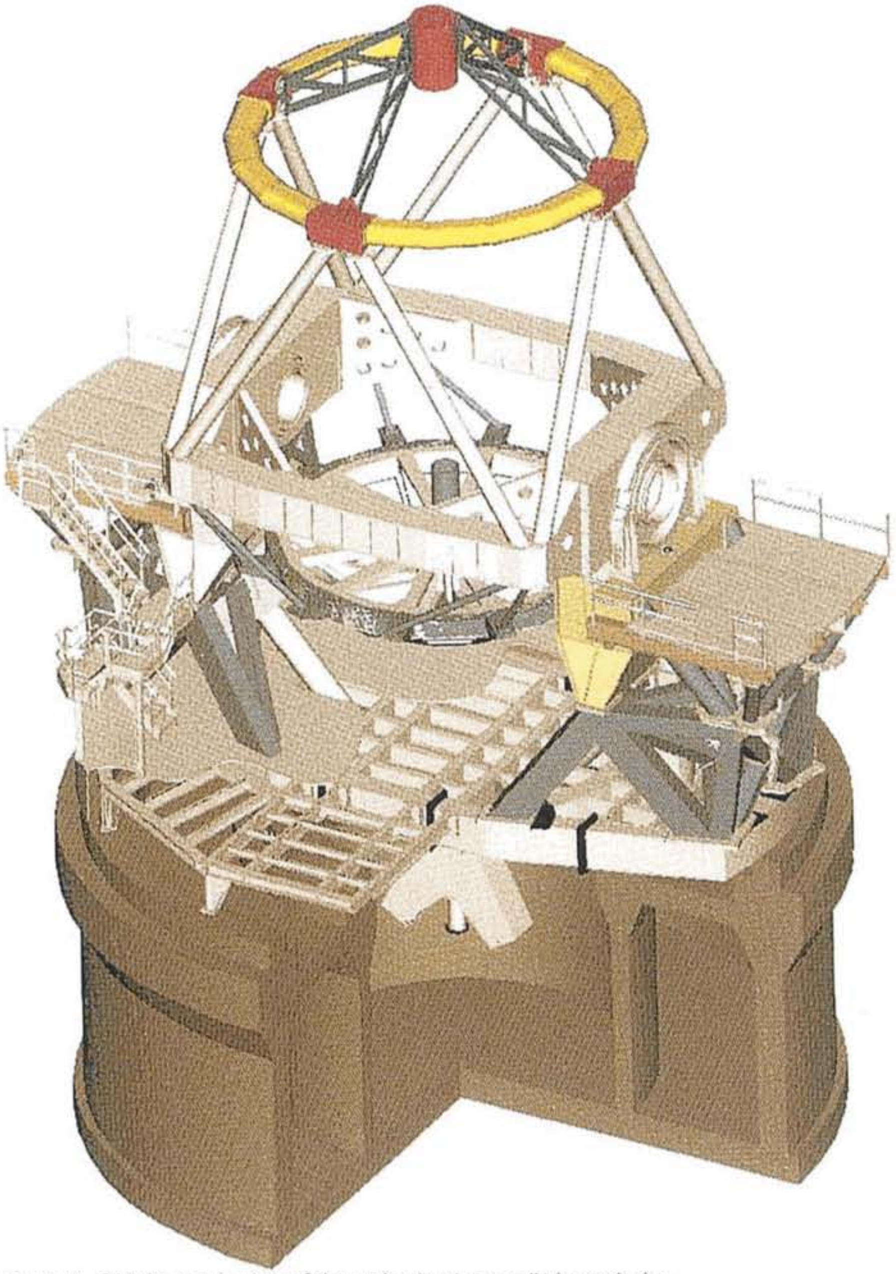

Figure 3: *CAD isometric view of the main structure preliminary design.*

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.

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

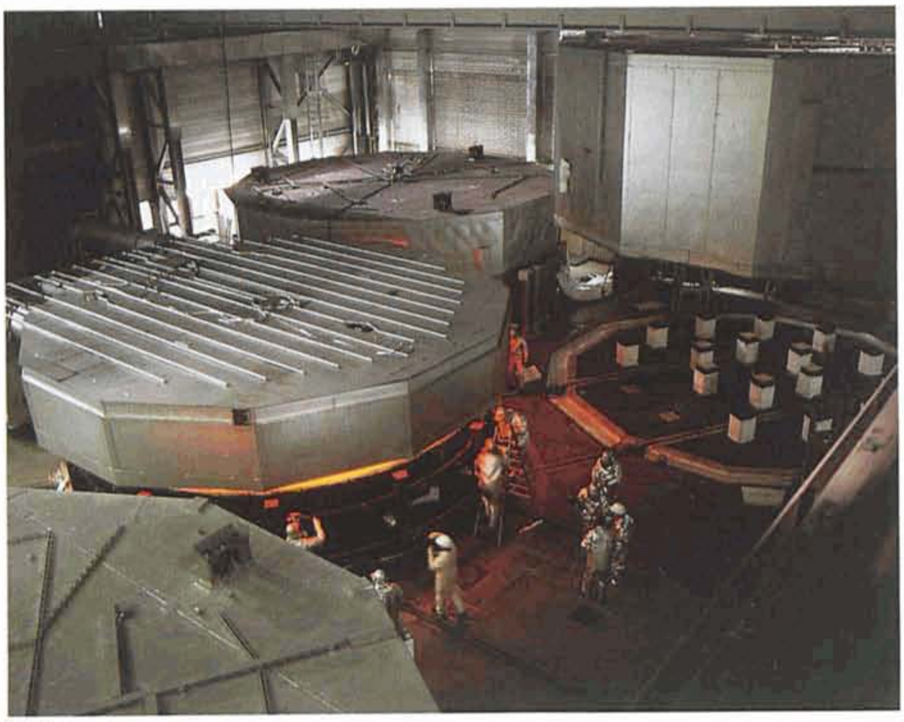

Figure 1.

has undoubtedly been a fantastic achievement.

However, manufacturing an 8-m-class Zerodur blank is a fairly delicate task, which eventually requires full-scale tests, even after validating the spin-cast technology up to the 4-m range. The key issue is that a crystalline layer inevitably builds up at the bottom and outer edges of the blank, where the liquid glass comes into contact with the insulating material of the mold. This crystalline layer has a different coefficient of thermal expansion than the glassy Zerodur, stresses build up during the cooling phase and may eventually lead to an overall breakage. By a proper selection of the insulating material and, to a lesser extent by an accurate thermal control of the casting process, the thickness of the crystalline layer may be reduced. With the first castings, the layer was a few millimetres thick, a figure that has now been brought down to about 0.2 mm. According to an analysis made on the first castings, the homogeneity of the material is exceptionally high.

The manufacturing process includes the following major steps:

1. casting, which lasts several hours;
2. annealing: the blank is cooled down and annealed in a dedicated furnace (about 4 months);
3. machining of both concave and convex sides;
4. ceramization (about 8 months);
5. drilling of the central hole;
6. fine annealing;
7. fine machining.

Probably the most critical operation, apart from the annealing, is the handling of a mirror blank when it comes out of its first annealing cycle. At this stage the crystalline layer is still partially adhering to the blank, which is therefore extremely fragile. While the blank is being transported and turned upside down onto the grinding machine, chips of glass are falling from the convex side. The noise is almost imperceptible... and definitely frightening. In order to provide the smoothest possible handling conditions, SCHOTT designed and built an 18-cup vacuum lifter, which performed remarkably well.

With the last upgrade of the insulating material, the convex surface is very smooth and there are no longer chips of glass to gather for decoration of one's desk.

The zero-expansion property of Zerodur is achieved after the ceramization cycle. Following very successful results obtained with 4-m-class prototypes, it has been tried to skip the annealing cycle, i.e. directly ceramize the blank after casting. The trial was unfortunately not successful.

During ceramization the active mold follows the shrinkage of the material, in order to ensure a proper distribution of the weight of the blank onto its support. By the time this article is published, the first ceramized Zerodur blank should come out of the furnace. After final machining it will have a mass of about 23 metric tons.

For the time being there are 5 blanks in the production line. The pictures shown here were taken upon the last casting early February 1993. After casting, the mold is transported from below the melting tank onto a rotating platform where it is spun for about one hour, after that the cover of the mold was lifted a few centimetres. The temperature of the liquid glass is about 1300 C. It solidifies fairly rapidly. After spinning, the cover is removed and a cooling cover is brought over the mold (Fig. 1). The few minutes where the glass is uncovered are just enough to understand what is thermal

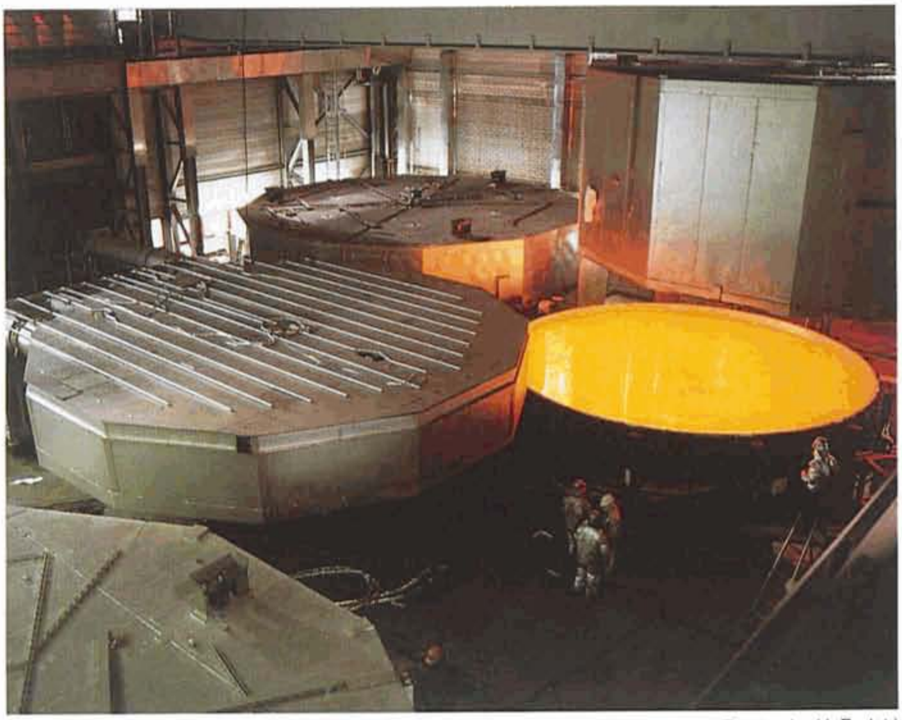

Figure 2.

(Photos by H. Zodet.)

radiation. Once the glass has cooled down to about 800 – 900 C, the mold is brought into the annealing furnace (Fig. 2) where it will stay for several months.

There will be one more casting, the goal for SCHOTT being to manufacture a total of 6 blanks, four of which will be delivered to ESO and the two others will wait for potential customers. At the latest in July the melting tank which has been in continuous operation since 1990 will be shut down.

Glass making is a very specialized field, which combines tradition, dedicated experience and modern technologies. Making 8-m-class blanks is a fascinating achievement. Moreover, other fascinating achievements are still to come, with the work of the polishing tools.

Seeing at Paranal: Mapping the VLT Observatory

M. SARAZIN, ESO-Garching, and J. NAVARRETE, ESO-Paranal

Modifying the shape of a summit after it was chosen for its outstanding qualities in optical turbulence raised justified concerns in the community about possible perturbations of the local flow pattern and their possible negative effect on the astronomical seeing. Numerical simulations had been performed at RISOE, Denmark, for various input wind conditions predicting neglectable effects at the northern and southern edge of the new 25,000 square metre telescope area. It was nevertheless not without some apprehension that we pushed the "start" key of the seeing monitor, now located on the newly formed VLT platform, on November 29, 1992.

The VLT observatory was greeting its first pieces of optics with the impressive sight of perfect flatness only broken by four huge holes giving the scale of the future observatory (Fig. 1). The Differential Image Motion seeing monitor which was used that night (DIMM1) was incidentally the same as the one started in April 1987, on the same summit, then 28 m higher when the seeing survey was initiated. During this survey, the 35-cm diameter Cassegrain telescopes were operated on concrete platforms at 5 m above ground. This was considered a lower height limit for the position of the primary mirror of modern telescopes.

Because of manpower shortage, it was unfortunately impossible for the VLT civil engineering department to design, for the new measurements, a tower which could be easily removed during the VLT erection phase. The DIMM1 telescope was thus installed on a 1 m high platform convenient to protect the optics from local dust. This was however not high enough to escape thermal turbulence in the surface layer,

Figure 1: *Location of the seeing monitoring stations in the new VLT telescope area.*