Manufacturing of the VLT Primary Mirrors – a Brief Progress Report

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Of the four primary mirrors of the VLT, two are presently under figuring at REOSC's plant in St. Pierre du Perray, and two at SCHOTT's plant, one under fine annealing and the fourth ready to have its centre hole ground out. For comic's addicts, these are Joe, Jack, William and Averell.

Joe's first light occurred in December when REOSC switched from infrared to visible interferometry. Figure 1 shows the mirror being cleaned prior to an optical test run. The robot arm is visible at the left; at the centre of the picture is the cleaning head which projects water onto the surface. At the top of the picture is the lower opening of the inflatable skirt. Upon testing the latter descents down to the edge of the mirror to provide a suitable thermal insulation of the test tower. Polishing is due to proceed until May 1995, and the current status of the mirror is about 1 micron RMS wavefront error. Consistent data obtained through different test setups show that the curvature and conic constant are already within tolerances. A definite confirmation should be obtained upon acceptance tests in May/June. The accidental scratch that occurred early 1994 has been totally polished.

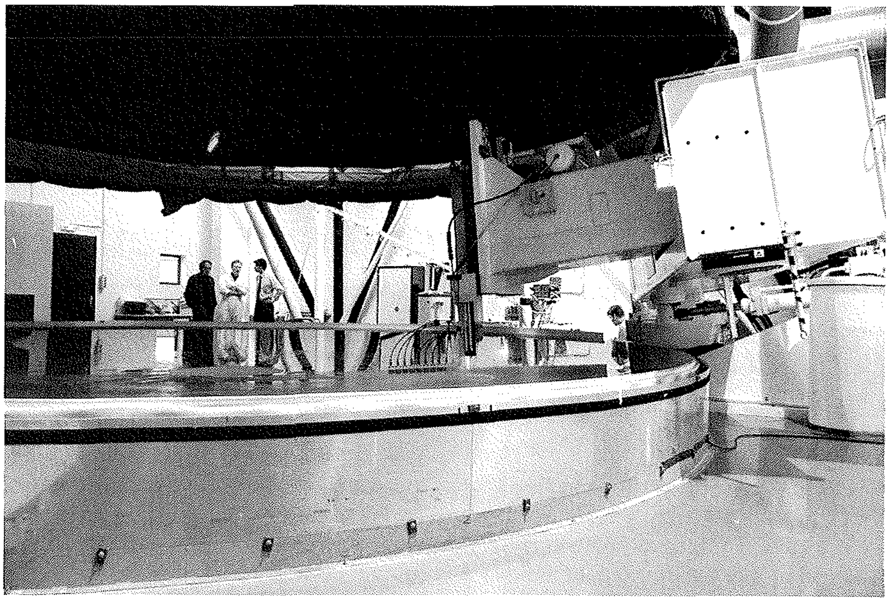

Figure 1: *Joe being washed (with permission by REOSC).*

Figure 2: *Jack's arrival at the optical figuring plant (with permission by REOSC).*

Jack was delivered by SCHOTT in October 1994. Final inspection revealed outstanding geometrical accuracy and internal quality, in line with the first (and then rated exceptional) achievements made by SCHOTT with Joe. Bubble and inclusion content is extremely low. Compressive stresses around the centre hole are somewhat higher than with Joe, but still within the standard for special quality Zerodur. Transport to REOSC took quite some time because of bad weather conditions in the Channel. Figure 2 shows Jack's arrival at the REOSC plant at 2:00 a.m. on November 22, 1994. The background shows the new REOSC plant built next to the VLT facility. Since then the axial pads have been glued and grinding is starting. Delivery of the finished mirror (ex works) is scheduled for June 1996.

William should be delivered by SCHOTT in July/August 1995. At the moment it is under ceramisation and should come out by mid-May for final machining. Averell is under quality inspection prior to grinding its centre hole. Delivery is foreseen in October.

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Impact of the Microseismic Activity on the VLT Interferometer

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1. Introduction

In a previous article ("Hunting the Bad Vibes at Paranal", Messenger No. 76 – June 1994), we described the approach followed by ESO to investigate the effect of microseismic noise on the VLT Interferometer (VLTI). In section 4 of that article, we presented a measurement campaign performed at Paranal to precisely characterise the natural microseismic activity in view of assessing its impact on the VLTI performance. At that date, only preliminary results were available and presented.

This article presents the final results of this campaign which provide the statistical characterisation of the micro-activity as seen from Paranal, as well as the evaluation of its impact on the stability of the Optical Path Length inside the VLT 8-m telescope.

2. Characterisation of the Natural Seismic Activity at Paranal

As a preamble to the field experiment at Paranal described in the next sections, the Ecole et Observatoire de Physique du Globe de Strasbourg (EOPGS) performed for ESO a specific processing of the seismic data obtained with its permanent monitoring network installed in the Antofagasta area since 1990. This processing consisted in characterising the seismic activity in that area in terms of earthquakes' magnitude (Richter scale), precise localisation of the sources and frequency of occurrence. Figure 1 illustrates a result of this pre-study. It shows the location of earthquake epicentres and their magnitude for a one-year period (July 1990–June 1991).

2.1. Field experiment

The field experiment was carried on from March 21–31, 1994 at Paranal by Dr. L. Rivera, seismologist from EOPGS, and B. Koehler from ESO-Garching with the logistic support of ESO-Paranal.

Three different kinds of ground motion were recorded during this period: (i) background seismic noise samples in the absence of any seismic events or artificial disturbance, (ii) seismic events due to earthquakes, (iii) human-made noise samples. The noise samples were recorded continuously within pre-defined time windows; with duration ranging from 2 to 10 minutes. The sample frequency used was 500 Hz and occasionally 1000 Hz. Seismic events, on the other hand, were recorded by triggering; the signal was continuously digitised and fed to a detection algorithm which decided whether "an event" was presently arriving. In this case, the recording was activated including a pre-trigger window. A sample frequency of 250 Hz was selected.

All noise samples were recorded during the night at the location of Telescope No. 4. The seismic events were monitored during day and night at the same location but also at the so-called "NTT peak" some 1.5 km north-east from the Paranal top to avoid contamination by human activity during certain days.

The measurement set-up included two types of high-sensitivity seismometers; uni-axial Kinemetrics SS-1 and tri-axial Mark-Product L4-3D. Both are velocity transducers based on the spring-mass principle. The inertial motion of the mass/magnet with respect to the outer cage equipped with a coil creates a voltage proportional to the velocity of the seismic mass.

A Reftek 72A-07 seismic station was used to digitise and record the signals coming from the seismometers. The A/D conversion (24 bits) was performed at a very high sample rate of 16 kHz, then a digital FIR filter was used to perform anti-alias filtering of the raw data. Finally the data were decimated to the selected output sample rate.

A portable Sun Workstation was also brought to the field, in order to read the tapes, visualise the signals and make a preliminary signal analysis.

The resolution and the noise of the whole acquisition chain was carefully computed and experimentally checked. The resolution was 3.10^{-10} m/s and the noise power spectral density 2.10^{-10} (m/s)/$\sqrt{Hz}$). This very high sensitivity prevented to be limited by the measurement noise even for the very low level of the natural background seismic noise.

2.2. Data analysis and results

The total effective time of seismic monitoring by triggering was 125 hours. Figure 2 shows a typical example of recording. A total of 164 events due to earthquakes were recorded during the time mentioned above. For each of them, the following parameters were calculated: (i) the distance of the earthquake epicentre from Paranal, (ii) the seismic moment, (iii) the Richter magnitude and (iv) a parameter representing the level of the local ground acceleration called Γ, and defined later in this section.

Distance between Paranal and the earthquake source were obtained from the so-called, S-P delays. Indeed, even though the propagation speeds of the shear (S) and compression (P) waves varies with the local earth material, their difference is almost a constant. This permits to determine the distance from the difference of arrival times of the two waves. Figure 3 shows a histogram of the number of recorded events as a function of their distance. Some interesting remarks can be made from this histogram (see caption of Figure 3). The most important one is the absence of seismicity closer than 25 km. This indicates the absence of earth-