Site Evaluation for the VLT: DIMM3 in Operation

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There has been a lot of activity within the VLT sites' study since our last *Messenger* report [1]. The VLT site group in Chile welcomed new members to face the increasing workload due to the simultaneous operation of three seeing monitoring stations in addition to the measurements of precipitable water vapour and cloud cover survey initiated in 1983.

The main instrument on each site is the Differential Image Motion Monitor (DIMM) described in [2] which delivers the image quality of an equivalent one-minute exposure made at the focus of a large telescope of perfect optical quality. In addition to the DIMM, the altitude distribution of the turbulent layers is estimated using a set of three instruments: a scintillometer, more sensitive to turbulent activity occurring at high altitude, an acoustic sounder (SODAR) for the 30 m to 800 m range, and microthermal sensors for monitoring local effects.

The current study focuses on three candidates and is now entering its ultimate year before the final choice of the VLT site. Here is some miscellaneous information:

DIMM 1, installed in April 1987, is consistently providing confirmation that **Cerro Paranal,** 2664 m, is definitely a sub-arcsecond site, with a yearly 50 percentile FWHM of 0.9 arcsec at 0.5 μm in 1988. The minimum 1-min record was 0.27 arcsec, the seeing was lower than 0.5 arcsec during 5 % of the observing time, while 95 % of the measurements were under 1.6 arcsec.

On **Cerro Vizcachas,** since October 1988, at 2400 m altitude, 6 km southeast of La Silla, DIMM2 has already earned itself a reputation among visiting astronomers. Thanks to the very good correlation between observing conditions on the two sites, La Silla has become the first astronomical observatory to provide seeing information on line: dial the 4128 from your control room and the Vizcachas operator will give you the current situation and trend. Sorry, no forecast available yet, since seeing meteorology is a brand new science, but there are good hopes that specific numerical models can be developed in the future to adapt the VLT operation to the local observing conditions on the basis of forecasts delivered a few hours in advance.

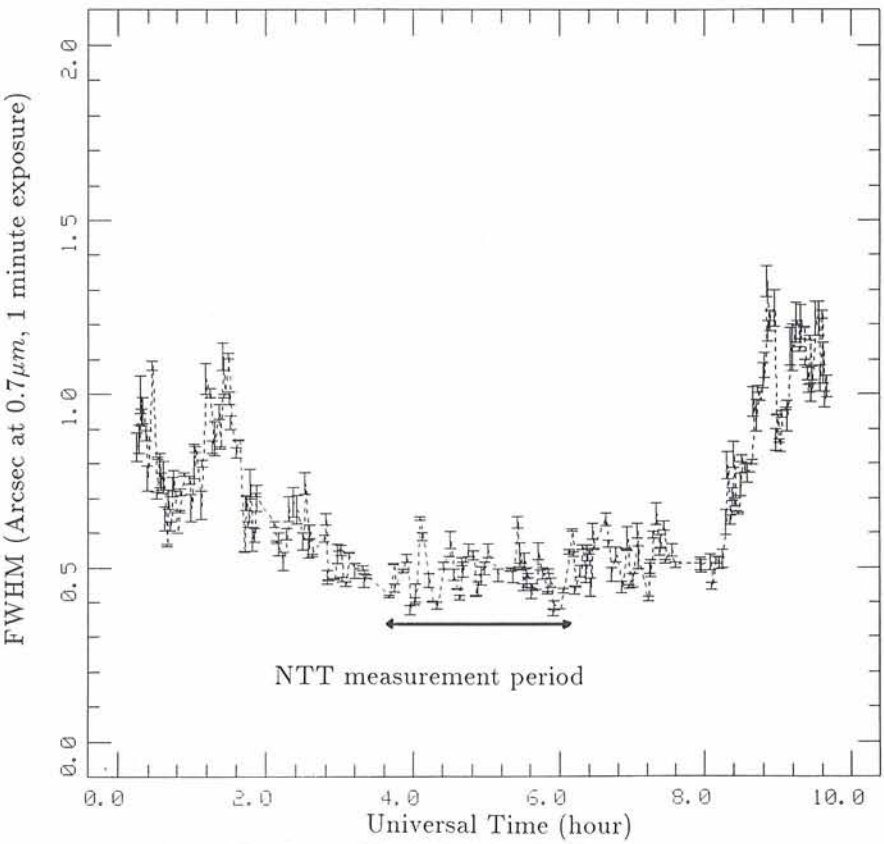

Figure 1: *The seeing at Vizcachas on March 23, during the NTT active optics installation.*

Recent seeing measurements made at the NTT during the installation of active optics confirmed again the excellent correlation of the observing conditions at La Silla and Vizcachas. Figure 1 shows of the DIMM2 seeing record on March 23, when a 10-second CCD exposure recorded at the NTT showed an impressive full width half maximum of 0.33 arcsec. During the same period, the best 1-minute average seeing measured 5 metre above ground at Vizcachas was 0.37 arcsec at 0.7 μm. For such a low value the DIMM, with a signal-to-noise ratio greater than 5, was still far from its limit. The oscillations seen on the graph correspond to real

IMPORTANT NEWS ON VLT INSTRUMENTATION

A document "ESO VLT Instrumentation Plan: Preliminary Proposal and Call for Responses" will be distributed in June to Institute Directors, libraries and ESO Committee members. It presents a preliminary instrumentation plan for the VLT and outlines possibilities and requirements for the participation of ESO Member State Institutes in its implementation. Responses from the community are invited by November 1989, after which it is intended to finalize this plan and prepare the first Call for Instrument Proposals. A limited number of additional copies will be available from the Project Division (VLT Instrumentation Plan) at ESO.

Figure 2: *DIMM3 tower and control room on Cerro La Montura. The sharp summit of Paranal can be seen in the background.*

atmospheric short-term instability. These are much larger than the DIMM uncertainty given by the vertical error bars (statistical error $< \pm 5\,\%$).

DIMM3 was first used to check the comparability of its two predecessors before being transported to the newly equipped summit of **Cerro la Montura,** 2509 m, 4 km north-east of Paranal, shown on Figure 2. Contrary to Vizcachas and La Silla, those two northern summits present very different wind patterns. This has raised some concern that the lower wind velocity found at La Montura might be traded against an increase of local seeing. Regular measurements started there on April 1 to detect possible differences with the nearby Paranal.

References

1. H. Pedersen et al.: Seeing Measurements with a Differential Image Motion Monitor; *The Messenger* No. 53; September 1988, 8–9.
2. M. Sarazin, F. Roddier: The ESO differential image motion monitor; submitted to *Astron. Astroph.*, Feb. 1989.

The VLT in the Wind Tunnel

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Introduction

Increasing evidence collected over recent years has shown that the best local seeing conditions are found when the telescope is exposed to an undisturbed moderate wind flow. This recognition has contributed decisively to direct the design of new telescope buildings towards more open and, incidentally, cheaper solutions than the conventional domes.

The unit telescopes of the VLT are being designed for operation in the open air with a fully openable inflatable dome at present considered for daytime protection. With this concept the wind becomes an important loading condition in the design of the telescope and its effects must be quantified accurately. In order to provide the required data, a series of wind tunnel tests has been performed with models of the VLT unit telescope and its enclosure.

Wind Tunnel Simulation

The basic problem of tests at a reduced scale is that it is seldom possible to scale down all intervening quantities. This is also true for wind tunnel tests where, for instance, it is obviously not possible to scale down the air molecules and gravity. One has to identify the main factors which determine the amplitude of the aerodynamic force for each particular case, then try to simulate those factors as accurately as possible and estimate the corrections due to other parameters which cannot be simulated rigorously.

The aerodynamic force applied on an object is conventionally defined as:

$$F = \frac{1}{2} C_p S \varrho V^2 \qquad (1)$$

with V the flow velocity, ϱ the air density, S a reference surface (generally the exposed cross-section) and C_p an adimensional coefficient mainly dependent on the object shape, but also on the relationship of some flow characteristics to the scale of the object.

In general, the largest part of the aerodynamic force applied on an object depends on the size, number and type of the vortices generated in the wake. For low velocity flows such as atmospheric wind, this wake turbulence, hence C_p, is mainly affected by two parameters: the turbulence already present in the upstream flow and the Reynolds number, which expresses the product of geometry and velocity scales, relative to viscosity.

The first consequence is that, since the atmospheric boundary layer is turbulent, this turbulence must be reproduced in the wind tunnel upstream of the model. This requires special installations, properly called boundary layer wind tunnels, which have a rectangular cross-section and a length sufficient to build up a scaled down atmospheric turbulence upstream of the test model. Even in such wind tunnels, however, it is not possible to achieve a complete Reynolds number similarity: this would require that velocity be increased by the same factor as the geometry scale is reduced, which in many cases would make the flow supersonic. Nonetheless, the C_p of sharp-edged objects is not too dependent on the Reynolds number, so that the measurements are generally accurate enough for most purposes in building engineering, where the objective mostly concerns the determination of ultimate dimensioning loads, to which some safety margin is anyway added.

In the VLT case, the determination of wind loading is required to quantify the "normal" performance of the telescope, hence a greater accuracy is desired than the one achievable in standard tests. Furthermore, the telescope structure is made of round section members, which have a low drag but also a C_p which is quite dependent on the Reynolds number. Therefore, the wind tunnel test measurements on the VLT model had to be complemented and corrected by separate tests of telescope bar elements at both full and model scale. The measurements were then used to calibrate and validate a detailed numerical model of the telescope. In this way, not only the full scale loads on the telescope were evaluated with better accuracy than otherwise achievable, but also further possible design changes of the telescope structure will not need new tests, but just a new run of the numerical model with updated inputs.

Some Results

While it is not the purpose of this article to present all the results of the VLT wind tunnel tests, below are a few examples which illustrate some interesting aspects of this work.

The scale of the VLT model was 1 : 80. Two different enclosure configurations were tested in the wind tunnel, both of which assume an inflatable dome fully open during observations. The first enclosure surrounds the tele-

(a) (b)

Figure 1: *Some of the configurations tested in the wind tunnel: (a) Telescope imbedded in a recess platform. (b) Open platform with the telescope exposed.*