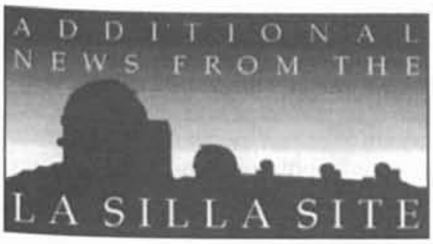


The La Silla News Page

The editors of the La Silla News Page would like to welcome readers of the third edition of a page devoted to reporting on technical updates and observational achievements at La Silla. We would like this page to inform the astronomical community to changes made to telescopes, instruments, operations, and of instrumental performances that cannot be reported conveniently elsewhere. Contributions and inquiries to this page from the community are most welcome. (P. Bouchet, R. Gredel, C. Lidman)

Image Quality of the 3.6-m Telescope

S. GUISARD, ESO-La Silla

Another 3 test nights were used during the beginning of February for testing the optical performance of the 3.6-m telescope. The first two nights were dedicated to the realignment of the secondary mirror and to the study of the relative movement of the primary and secondary mirrors with telescope position. Antares, a wavefront analyser, was used for this purpose. The third night was used for image quality measurements. Very promising results were obtained.

Image Quality

The term image quality is defined here as the full width at half maximum (FWHM), usually expressed in arc seconds, of a stellar image as measured at the detector in real observing conditions. Within the astronomical community, it is termed, somewhat improperly, "the seeing".

The image quality depends on several parameters:

(a) The optical quality (telescope and instrument)

For this study we measured the image quality at the Cassegrain focus with a direct CCD. Therefore, we do not include any image degradation from instruments.

The optical quality depends on :

– the diffraction limit;

– residual aberrations from theoretical optical design;

– intrinsic optical quality (due to the figuring of the optics);

– positioning of the primary and secondary mirrors with respect to each other (this includes spacing, tilt and decentring, and the variation of these parameters both with zenith distance and movement of the telescope);

– support of the mirrors (quality of the support at zenith and variation with zenith distance).

(b) The seeing

The seeing is the degradation of the wavefront by the entire atmosphere, from the high atmosphere down to the air layers near the detector. It is usually decomposed in several components: outside seeing (site seeing), dome seeing, mirror seeing, instrument seeing, although the phenomenon for each component is the same. The cause of seeing is temperature inhomogeneities in the air which induce phase differences in the optical path. The effect is to smear the light of a star. Usually the atmosphere is the worse part of the telescope. In the case of the 3.6-m we shall see that this is not completely true.

(c) Other parameters

– focusing the telescope
– sampling of the detector
– guiding accuracy
– vibrations of the telescope

The image quality study aims at analysing and reducing all the above-mentioned effects at the 3.6-m.

Results of the Study at the 3.6-m, February Test Nights

(a) The optical quality of the telescope

After realigning M2 with respect to M1 during the two first nights (this removes the decentring coma) the following aberrations remained. The telescope was pointing at the zenith. All the values represent the diameter of the circle containing 80% of the light. The unit is in arc seconds.

Decentring coma:	0.11″
Astigmatism:	0.40″
Triangular astigmatism:	0.45″
Quadratic astigmatism:	0.20″

The combination of all these aberrations would produce an image of 0.65″ diameter (80% light) in the absence of atmosphere and seeing effects. It is not the optimal value as the intrinsic optical quality of the telescope (mirror perfectly aligned, perfectly supported, no atmosphere) is less than 0.4″.

The remaining astigmatism and triangular astigmatism are too high. These aberrations are due to the M1 support. In fact, they appeared after the last aluminisation (October 1994). Before this, the values used to be lower than 0.20″. Several problems concerning the lateral pads of M1 were found and partly solved. It is foreseen during the next aluminisation period (June 1996) to check all the forces applied at the back of the mirror, and to also check the lateral pads.

It is important to note that these values are for the telescope pointing at the zenith. We have known for a long time that telescope flexure associated with observing away from the zenith causes the optical quality to deteriorate rapidly.

During the third night the stability in the image quality with telescope movement was measured. The telescope was first moved to the south to a zenith distance of 60 degrees and then returned to the zenith. The optical quality at the zenith was measured to be 1.0″, significantly larger than the 0.65″ measured at the zenith before the telescope was moved and after alignment of the primary and secondary mirrors. It nearly comes back to its original value if you go north and come back to zenith. Further tests will be performed to measure the movements of M1 and M2 for different positions of the telescope.

(b) Seeing at the telescope

A seeing monitor (dimm4) was installed recently on the tube of the telescope to measure the combination of the site and dome seeing. Comparison between these values and those measured by the outside seeing monitor (dimm2) will give us the dome seeing. These measurements need to be done over a one-year period so that seasonal effects can eventually be detected.

Using the experience gained at other observatories, a mirror cooling system is being studied. The heat produced inside the cage will be removed with a cooling system.

(c) Image quality measurements

We measured with a direct CCD (0.19″ per pixel) the FWHM of a star near the zenith. The measurements were done during the third night test. Antares was mounted during the beginning of the night to check the optical quality; it was still 0.65″. We stayed near zenith to avoid the non elastic movement of the telescope mechanics and optics.

The site seeing was good all night, an average of 0.73″ with 48 measurements. At the 3.6-m, the average image quality was 0.92″ (48 measurements). This is by far the best result achieved during all the test nights. The best result was around 0.73″, near the actual optical quality of the telescope (0.65″). The worst value was 1.05″. These results are compared to the results obtained during previous test nights which are shown in Table 1.

TABLE 1.

	2 Sept. 1995	3 Sept. 1995	4 Sept. 1995
Average dimm2	0.70″	0.66″	1.27″
Average 3.6-m	1.21″	1.30″	1.46″
Best value 3.6-m	1.02″	0.96″	1.21″
Worse value 3.6-m	1.40″	1.70″	1.70″
Number of measurements	13	16	6
	4 Oct. 1995	5 Oct. 1995	30 Nov. 1995
Average dimm2	1.13″	1.04″	1.11″
Average 3.6-m	1.26″	1.15″	1.18″
Best value 3.6-m	1.00″	0.93″	0.99″
Worse value 3.6-m	1.51″	1.41″	1.36″
Number of measurements	25	24	22
	1 Dec. 1995	2 Dec. 1995	9 Feb. 1996
Average dimm2	0.90″	1.00″	0.73″
Average 3.6-m	1.16″	1.26″	0.92″
Best value 3.6-m	1.01″	1.09″	0.73″
Worse value 3.6-m	1.36″	1.53″	1.05″
Number of measurements	30	48	48

The average value during the last night test is better than any single measurement made during the other test nights. Although the outside seeing values are not comparable for all the nights, the nights of September 2 and 3, 1995 showed outside seeing values very near to the night of February 9, 1996.

The good results of the last night run can be explained by:

– the temperature differences throughout the dome were smaller than normal,

– the optical alignment was good and was checked before the observations,

– the telescope stayed near the zenith,

– outside seeing was good.

So, can the astronomer expect similar results? Unfortunately, the answer is no. Even if a detector with the appropriate sampling would be available, the following conditions for good seeing at the 3.6-m have to be satisfied:

– good external seeing;

– observation only near zenith (because of the flexure in the telescope mechanics and movement of the optics);

– good optical alignment of the primary and secondary mirrors. (Even at the zenith, it is not certain that the primary and secondary mirrors will remain aligned from the previous night. This is due to the non-elastic movements produced in the M2 unit. The only way of verifying the alignment would be to do an image analysis with a wavefront sensor before observations start);

– the air temperature within the dome is homogeneous.

Conclusion

The results obtained during the last test period are very promising. We have shown that images with 0.7″ to 0.9″ FWHM are possible during a whole night. However, we also have found what is required to get these results. To progress further at the 3.6-m we need to:

– continue the effort of eliminating the hot sources in the dome and to eventually insulate the concrete walls;

– change the M2 unit to a NTT-like M2 unit that would enable us to compensate for tube flexure when observing away from zenith. It would also eliminate the non elastic phenomena present in the actual M2 unit design;

– a Wavefront analyser can easily be installed inside the rotator, it would be very easy to activate (or semi-activate) M2.

In fact, the recommendations I made above, which are a conclusion of the night tests, are not far from the following: "The potentially excellent optical quality of the 3.6-m can only be exploited if improvements in dome and telescope seeing are effected and a high precision of centring maintained" (Ray Wilson, ESO Technical Report No. 8, October 1977).

About the Photometric Stability of EFOSC1

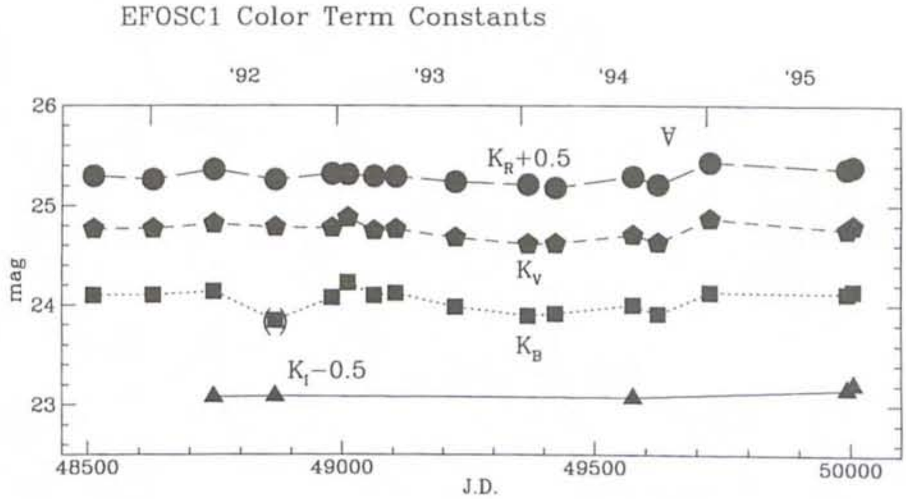
S. BENETTI, ESO-La Silla

This brief report deals with the long-term photometric stability of EFOSC1. EFOSC1 is a focal reducer attached to the Cassegrain focus of the ESO 3.6-m telescope. EFOSC1 is equipped with CCD #26.

In this study, photometric standards, all from Landolt [*AJ* 104, 340 (1992)], were imaged during 16 photometric nights with the B, V and R_C filters. During five of these nights, standards were also observed with the I_C filter. The date of the observations span from September 11, 1991 to October 14, 1995. For all data, standard reduction procedures were applied (BIAS subtraction, and FF correction, with preference to sky FFs when available). When available, the extinction coefficients for the night (as found in the ESO-La Silla WWW pages) were used.

The equation ($M - m = S_m \times (B - V) + K_m$) was then fitted for each filter (m = B, V, R_C, I_C) and for each night. Averaged over all the nights the corresponding equations for EFOSC1 are the following:

$$B - b = +0.190 \pm 0.013 \times (B - V) + 24.06 \pm 0.09 \ (^*)$$
$$V - v = +0.050 \pm 0.011 \times (B - V) + 24.75 \pm 0.08$$
$$R_C - r = +0.011 \pm 0.012 \times (B - V) + 24.80 \pm 0.07$$
$$I_C - i = -0.035 \pm 0.002 \times (B - V) + 23.62 \pm 0.05$$



The instrumental magnitudes were calculated with the counts expressed in ADUs (the conversion factor for CCD #26 is 4e⁻/ADU).

The inverted A in the Figure shows the re-aluminisation date of the 3.6-m primary mirror (during October 18, 1994; the previous one was done during August, 1990). A significant increase in the efficiency is measured (especially in the V and R_C bands, see figure). If we compute the zero points for the observations before this date only, we get:

$$K_B = 24.05 \pm 0.09$$
$$K_V = 24.73 \pm 0.08$$
$$K_R = 24.77 \pm 0.05$$
$$K_I = 23.58 \pm 0.01$$

The zero points for the first point after the re-aluminisation (January 7, 1995) are 0.08 mag higher in B, 0.14 mag higher in V, and 0.16 mag higher in R_C.

From an inspection of the figure, it is clear that there is an overall fair photometric stability for EFOSC1 and that the fluctuations in the zero points are smaller than 0.1 mag for all filters. Furthermore, no obvious systematic trends are seen before October 1994.

(*) calculated without one anomalous point. This point is circled by parentheses in the Figure that shows the trend in the zero points, K_m, with time (Julian days).

Unusual View of VLT Site

Hanging from a crane, ESO photographer H.H. Heyer took this view over the VLT platform in the late-evening sunlight at the end of February 1996. Apart from the VLT Unit 1, with almost fully assembled steel structure, Unit 2 is behind at left and the interferometric tunnel stretches across at right.