# With its Optics Complete, the NTT Telescope Homes In

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On 11 May 1988 an important event took place for the development of telescope technology at ESO: the NTT optics was successfully tested at Carl Zeiss, FRG. This means that the three mirrors (primary, secondary and Nasmyth) are finished and within specification. The interferometric data currently available for the primary refer to this mirror on its manufacturing support (see Fig. 1). A further series of tests of the primary is scheduled for 1 July on the actual NTT support in its cell. Final acceptance will take place in the finished, functioning telescope in La Silla at the beginning of March 1989.

These results will not only be a milestone in the history of ESO but also a milestone in the history of the reflecting telescope in general. The NTT will be the first telescope to go into operation with a complete active optics control system to maintain constantly an optical performance which will exceed by a clear margin that of any other telescope ever built with the possible exception of the 2.4-m Space Telescope.

To understand the manufacture of the NTT optics, we must look at its specification for the final Nasmyth image:

(a) 80% geometrical energy within 0.40 arcsec

(b) 80% geometrical energy within 0.15 arcsec if 5 terms, to be controlled actively, are mathematically removed from the combined image forming wavefront (Intrinsic Quality).

The active control gives a relaxation of certain errors (such as astigmatism) which enables the manufacturer to concentrate above all on specification (b) which ensures very smooth surfaces without high frequency errors such as "ripple", zones or local bumps. In function, specification (b) should then operate all the time and will be the working specification of the telescope. This is quite near the "diffraction limit" for such a telescope.

The blank with aspect ratio 1 : 15 (2½ × thinner than the blank of the ESO 3.6-m telescope) was delivered from Schott to Carl Zeiss in June 1986. The blank itself represents a great technical achievement by Schott in zero-expansion glass ceramic, Zerodur. Two years of intensive work at Carl Zeiss followed and are now drawing to completion. The NTT specification (b) has required, and resulted in, a remarkable technological development at Carl Zeiss both in figuring techniques and in test technology. With the practical development of "stabilized phase interferometry", Carl Zeiss is now in possession of an excellent and time-saving technology in the manufacture of large optics.

The results of the Carl Zeiss interferometric tests, established in a most rigorous way, are as follows for the whole optical train M1, M2, M3:

(a) 80% geometrical energy within ca. 0.30 arcsec

(b) 80% geometrical energy within ca. 0.125 arcsec for the Intrinsic Quality.

Both values are thus well within the specification. Cross checks with the ESO Shack-Hartmann (ANTARES) test procedure are still being carried out but are essentially in agreement with the interferometric results. However, for technical reasons, specification (b) probably exceeds our measuring precision with Shack-Hartmann in the workshop setup, though we expect to achieve the required precision in the actual, functional telescope.

Meanwhile, work on the NTT telescope and building is advancing rapidly both in Europe and on its location at La Silla, Chile.

The mirror cell is now in Garching for the integration of the active support system and the associated electronics prior to its transport to Zeiss.

The civil engineering work was completed in February 1988, followed by the start of the construction of the rotating building (Fig. 3). At the end of May the steel frame and the external panels were in place (see figure on page 1). Completion is expected by July 1988.

In February and March of this year the telescope's mechanical structure was dismounted and packed at INNSE Brescia (Italy) – where it was manufactured – and then shipped from Genova to Chile on 29 April 1988 (Fig. 2).

On 31 May 1988 the ship "ISLA BALTA" carrying the telescope arrived in the Chilean harbour Valparaiso, and a few days later, on 3 June, the boxes containing the NTT reached La Silla. The enormous task of erecting the telescope will take almost 7 months to complete, starting in June 1988.

Apart from the technical achievement, the NTT contracts have been marked by an excellent spirit of cooperation between industry and ESO.

Figure 1: *The 3.58-m NTT prime mirror at Zeiss with many of the Zeiss colleagues who were involved at various stages of the optical figuring work.*


Figure 2: *Loading of the NTT boxes onto the ship in Genova harbour, 29 April 1988. In the front of the picture the box containing the base of the fork is visible. This box weighs about 44 tons.*

Figure 3: *The rotating building under construction in April 1988.*

# Speckle Masking Observations of the Central Object in NGC 3603, Eta Carinae, and the Seyfert Galaxies NGC 7469 and NGC 1068

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## Introduction

Speckle masking bispectrum processing yields diffraction-limited images in spite of image degradation by the atmosphere and by telescope aberrations. For example, with the ESO 3.6-m telescope a resolution of 0".028 can be obtained at $\lambda \sim 400$ nm. The limiting magnitude is $\sim 18^m$.

In speckle masking the same speckle raw data (speckle interferograms) are evaluated as in speckle interferometry. Speckle interferograms are short-exposure images recorded with an exposure time of ~ 10 to 50 msec. Speckle masking consists of the following processing steps (Weigelt, 1977; Weigelt and Wirnitzer, 1983; Lohmann, Weigelt and Wirnitzer, 1983):

(a) calculation of the average bispectrum of all speckle interferograms,

(b) compensation of the photon bias in the average bispectrum,

(c) compensation of the speckle masking transfer function,

(d) derivation of modulus and phase of the object Fourier transform from the object bispectrum.

We will show applications of speckle masking to various types of objects. The speckle raw data were recorded with the 2.2-m ESO/MPG telescope, the Danish 1.5-m telescope, and the 2.2-m Calar Alto telescope.

## Central Object in the Giant H II Region NGC 3603

NGC 3603 is one of the strongest H II regions in our galaxy. The central object in NGC 3603 is the star-like object HD 97950 AB. In various papers it has been discussed that this object may be of the same nature as R 136a in the 30 Doradus nebula. Figure 1 is the first diffraction-limited image which shows that the central object in NGC 3603 consists of six stars. In this experiment CLEAN was applied to the speckle masking reconstruction. The stars have magnitudes in the range of 12 to 14. The separation of the closest pair is ~ 0.09". The image was reconstructed from 300 speckle interferograms recorded with the 2.2-m ESO/MPG telescope (filter RG 610). An image of the four brightest stars was reconstructed by Hofmann and Weigelt (1986).

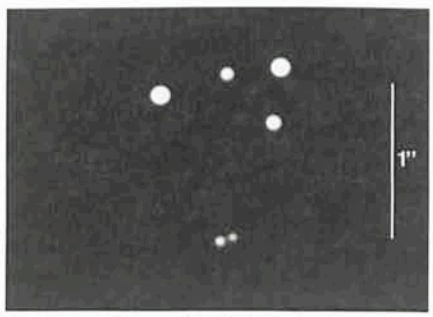


Figure 1: *Diffraction-limited image of the central object in the giant H II region NGC 3603 reconstructed by speckle masking (filter RG 610; North is at the top and East to the left).*

## Eta Carinae

η Carinae is one of the most peculiar objects in our galaxy. It underwent


Figure 2: *Diffraction-limited image of η Carinae ABCD (filter RG 830; North is at the top and East to the left).*