Fig. 5:
An interferometer on Cerro Paranal will combine the light of two or more ESO telescopes in an underground tunnel, providing images of significantly increased resolution. The VLT will then be able to simulate a telescope with a mirror diameter of 200 m and will "see" up to 100 times more sharply than Hubble. Zeiss is manufacturing mirror units for this interferometer. (Photos 4 and 5: ESO).

Light in the tunnel

The four 8 m telescopes and two 2 m auxiliary telescopes of the European Southern Observatory (ESO) installed on top of Cerro Paranal in Chile combine to form an oversized interferometer (Fig. 5). The interferometer's relay optics consist of sophisticated optical components interacting in an underground tunnel.

For a new component of this interferometer, Carl Zeiss is currently manufacturing 12 mirror units, and ESO has extended the existing contract for a total of 36 mirror units by another 10 units. The mirrors are coated, flat mirrors which deflect the incident light beam from the large telescopes, auxiliary telescopes or siderostats into the delay lines in the VLTI tunnel (Fig. 6). The optical surfaces are arranged in a vertical position and are used at an incidence angle of 45°. The operating temperature in the underground interferometer is 15 °C, and the same temperature is used for the final optical tests at Carl Zeiss. The 650 mm x 230 mm flat mirrors with two sub-pupils, each 200 mm in diameter, are made of AstroSitall ceramic glass and supported by a mount which must meet special requirements with respect to high eigenfrequency, light weight, high reproducibility and positioning accuracy. In view of the thermal and gravitational conditions, the specified optical performance can only be achieved with a wavefront error of <20 nm rms and a surface roughness of less than 1nm rms. A silver coating with increased reflection of as high as >98 % ensures that the reflectivity required is attained in most parts of the spectrum.

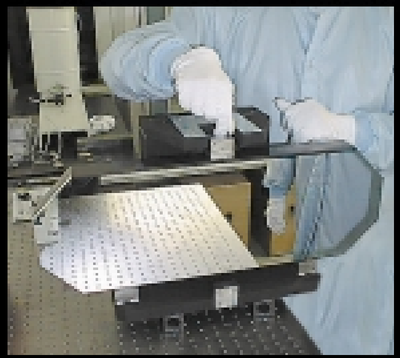


Fig. 6:
Mirror unit for ESO's VLT interferometer.

Where others take their vacation

The "Gran Telescopio Canarias" – GTC – with a segmented 10 m primary mirror is being built on the Canary Island of La Palma/Spain. Carl Zeiss manufactures and tests the GTC tertiary mirror in cooperation with its Russian partner LZOS. The Belgian company AMOS is handling this project as the principal contractor. GTC is a reflecting telescope with two curved, Ritchey-Chrétien mirrors feeding the Cassegrain focus. A flat, tertiary mirror can be swung into the light beam at the level of the elevation axis, directing the light to the Nasmyth foci or folded Cassegrain foci. To permit observation in one of the focus stations and to guarantee the specified image quality, the tertiary mirror must be equipped with a special mechanical suspension system and a drive system. The elliptically shaped tertiary mirror is made of Zerodur® and features a flat optical surface. Its major axis is 1514.9 mm long, its minor axis 1066.7 mm. The mirror surface must be polished to a surface roughness with a residual error in the range of 2 nm rms. The flat shape has a nominal radius of over 40 km.

Twins Observe the Sky

The GEMINI Project comprises two telescopes with an 8 m aperture and a 128 m focal length which observe the sky above the northern and southern hemispheres of the earth. The twins are located on top of Mauna Kea on the Big Island of Hawaii and on Cerro Pachón in Chile. Equipment of pivotal importance for the functioning of these telescopes came from Carl Zeiss. The second Gemini Acquisition and Guiding Unit (GAG) was supplied in April 2000, successfully completing the company's work on the GEMINI project which was commenced in 1996.

"First light" for the telescope on Mauna Kea was back in March 1999.

The use of the GAG systems was preceded by extensive tests focusing on functional verification in a temperature range from –20 °C to 25 °C and on "flexure tests" where the rigidity of critical assemblies was tested by tilting them by up to 90 degrees (Fig. 4).

These tests proved to be far more complicated than envisaged in the project schedule, as the commercially available measuring devices were found to be unsuitable and had to be replaced by customized measuring equipment and strategies.

Subsequent optimization made it possible, for example, to reduce the inclination of an assembly weighing 70 kg from 35 µm to approx. 9 µm.

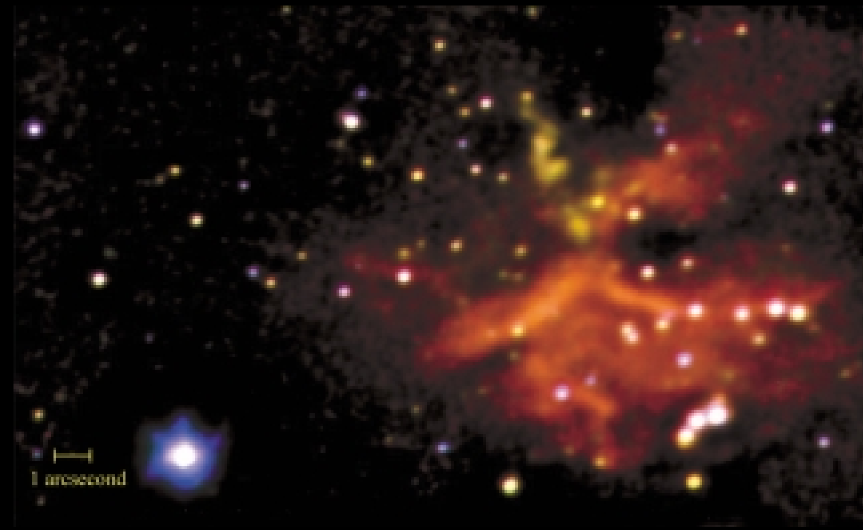
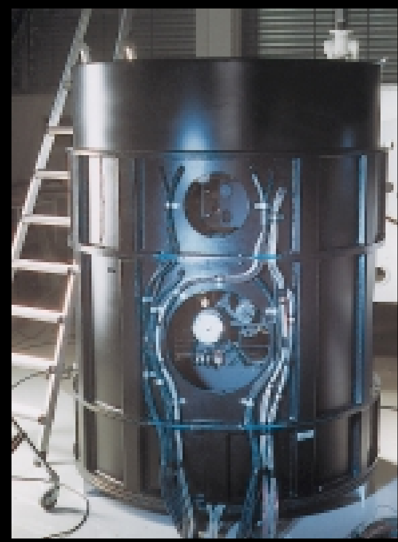


Fig. 1:
Star forming region G45.45+0.06. The photo was taken to mark the inauguration of the GEMINI North Observatory in June 1999. (Source: GEMINI).



Figs. 2 and 3:
The GAG Acquisition and Guiding Unit for the GEMINI North telescope during assembly (2) and before shipment (3).

Fig. 4:
Test setup for verifying the rigidity of the GAG system modules.