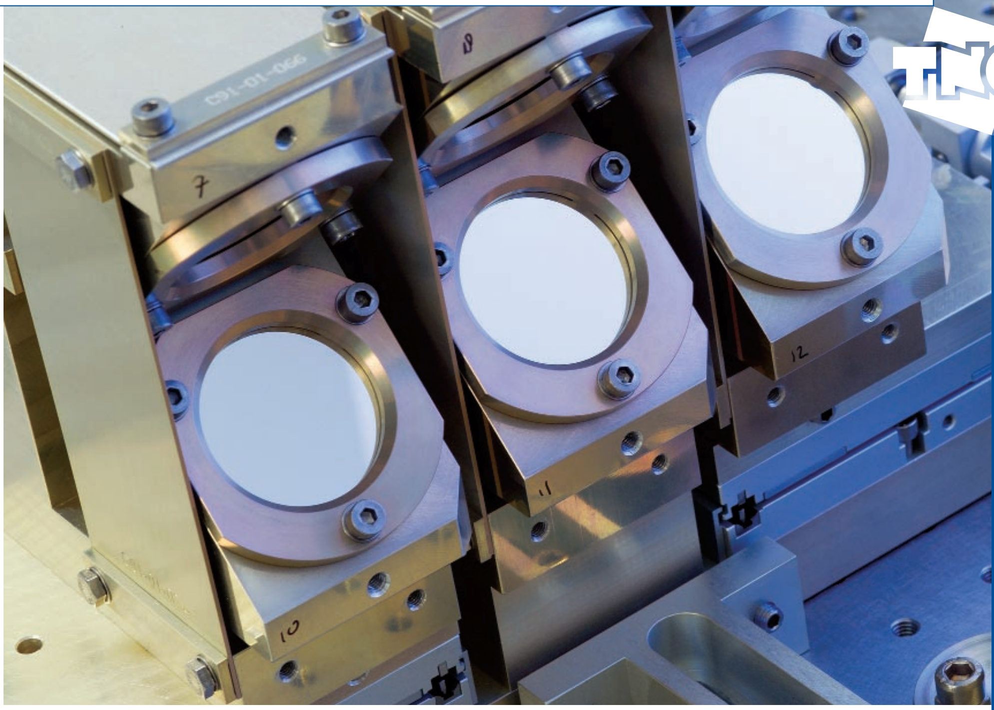
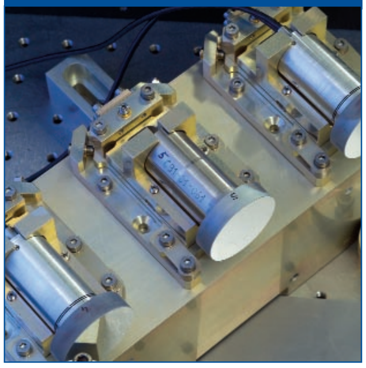
# Delft Testbed Interferometer



**TNO TPD delivers innovative and complete solutions for large companies, SMEs and the government. Our fields of knowledge are: acoustics and vibrations, models and processes, and imaging and instrumentation. Projects, both national and international, vary from system development to consultancy.**



*DTI is an optical testbed to demonstrate homothetic mapping, a special method for optical aperture synthesis. It has been assembled and aligned, and characterised. As a result it can be stated that all requirements posed on the system have been met. White light fringes on three 'stars' have been obtained proving that homothetic mapping is possible within the DTI system, a worlds first for TNO TPD.*
*DTI is a research topic of the Knowledge-Centre for Aperture Synthesis (KAS), and is available for researchers in the field of aperture synthesis and homothetic mapping.*

### Optical Aperture Synthesis

The resolution that can be obtained using a telescope system is primarily determined by the size of the first mirror, the larger its diameter, the smaller the details that can be resolved. Although telescope systems with 8 m primaries are in operation, there is the desire to have still better resolutions. Two ways to arrive at better resolutions exist: larger primaries in the telescopes, or combining several telescopes. The latter approach is known as optical aperture synthesis. If telescopes are combined, the obtainable resolution is inversely proportional to the baseline, the distance between the telescopes. Thus, further apart means a better resolution.
The light that is being measured is originating from a star and hence has a relatively large optical bandwidth. Since the contributions collected via the different telescopes has to be combined optically (the optical beams should interfere), the optical path lengths of the beams that should interfere, have to be arranged such that they result in zero optical path difference, zero OPD. To this end so-called delay lines are present in the system to equal the lengths of the separate optical paths.

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## Homothetic Mapping

In a general observation using a telescope system, e.g. VLT-I (the very large telescope interferometer) the telescopes are aimed at a certain star. The delay lines are set such that interference occurs for that specific star. A star that can be seen at a different location cannot be measured simultaneously since for each viewing angle a different OPD setting is required for the delay lines.

To overcome this field of view (FOV) problem the telescope signals should be combined using homothetic mapping. As is known, using a single optical element, a respectable FOV is obtained, e.g. the human eye. The idea behind homothetic mapping is to arrange the beams from the separate telescopes as if they originate from a single, very large, telescopes. The beams should be arranged in a layout that is a (scaled) copy of the telescope. Since the telescopes are viewing the sky under changing angles due to the earth rotation, and that the star has to be measured for a long period of time, the effective arrangement of the telescopes, as seen from the direction of the incoming light (from the star), changes continuously. This means that in a real telescope system the homothetic mapping system has to be adjusted to compensate for the rotation of the earth.

## DTI layout

In the Delft Testbed Interferometer the dimensions have been chosen to be a scaled copy of VLT-I. The scaling factor was set to 800 to arrive at a reasonable breadboard size. The light collecting apertures are 10 mm in diameter (VLT-I: 8 m) and the baseline equals about 125 mm (VLT-I: 100 m). The goal for the FOV of the VLT-I is set to 1 arcsec, such that for the DTI system the goal equals 800 arcsec.
The DTI system requirements are:

- mapping accuracy, lateral: 10 mm
- pointing accuracy: 3 mrad
- OPD accuracy: 20 nm

DTI is designed to enable the use of a patented mapping strategy. Instead of rearranging the mapping configuration to follow the star during a longer observation it is, according to our patent, better to keep the once aligned mapping arrangement and to only copy the viewing direction. The mapping arrangement should have rotational degrees of freedom to copy the viewing angle of the large telescopes.

DTI and all of its components were designed and produced at TNO TPD, apart from some small planar mirrors, the four tip/tilt piezo actuators and two motor driven translation stages.

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