

Excellent performance thanks to superb mechanics

Cats Eye



VLTi at Paranal, Chile.

The Cats Eye is an optical instrument for ESO, and is part of the Very Large Telescope Interferometer (VLTi). This system is built on top of the mountain Cerro Paranal in the Atacama desert in Chile. The delay lines, and in particular the Cats Eyes, make sure that the optical path length through telescope 1 and 2 from the incoming wavefront to the detector is identical to within 20 nm.

Main challenges

Superb mirror quality

- The mirror is polished horizontally and used vertically. The deformation of the mirror due to gravity is different for both situations and cannot be neglected. Therefore the mirrors have to be locally polished to compensate for this effect
- Polishing of the mirror is an iterative process. At regular intervals the mirror has to be tested in a special test set-up to verify the mirror shape. This causes extreme requirements for the reproducibility of the mirror mount.

Insensitive for temperature changes

- An all aluminium design (including mirrors) will uniformly expand and contract due to temperature changes. The optical performance of such instrument is not affected by this scaling effect.

- The secondary mirror is mounted in such a way that it has a thermal centre coincident with the optical axis. This means that temperature gradients cannot cause lateral displacements of the mirror.

Robust design

A robust design is needed because of earthquake sensitive area (up to force 8.2). Earthquake vibrations can cause:

- loss of stability of the instrument;
 - redistribution of internal loads.
- A kinematic mount avoids this.

Low maintenance

- Positioning of mirrors with the accuracy as required for such system, and subsequent testing, takes much time. Nominally, this takes 5 weeks. This was done before the instrument was delivered to ESO.



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Cats Eye: part of delay line for the VLTi (made by Dutch Space and TNO TPD).

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- At regular intervals it is necessary to dismount the mirrors for cleaning. Reinstalling would normally take again 5 weeks. However, the special way of mounting the mirrors, using a kinematic coupling, avoids this. Reassembling can now be done so accurately that realignment and retesting becomes unnecessary. Therefore the reassembly of the M1 takes about 0.5 hours. The other mirrors are reassembled in a few minutes.

Cats Eye performance

Cats Eye performs due to the application of kinematic mount because:

- the reproducibility position accuracy of the mirrors is better than $1 \mu\text{m}$, causing:
 - low maintenance;
 - maintenance can be done during day time, so no precious observation time of the telescope is lost.

- The Cats Eye is insensitive to temperature variations (thermal centre).
- The mirror forces are statically determined. External temporary loads cannot disturb the mirror loads permanently. The result is an extremely stable instrument.

General conclusion

The application of static determined structures (e.g. a kinematic mount) and design principles for precision engineering allow the combination of extreme requirements that cannot be met by conventional structures or only at great difficulty.

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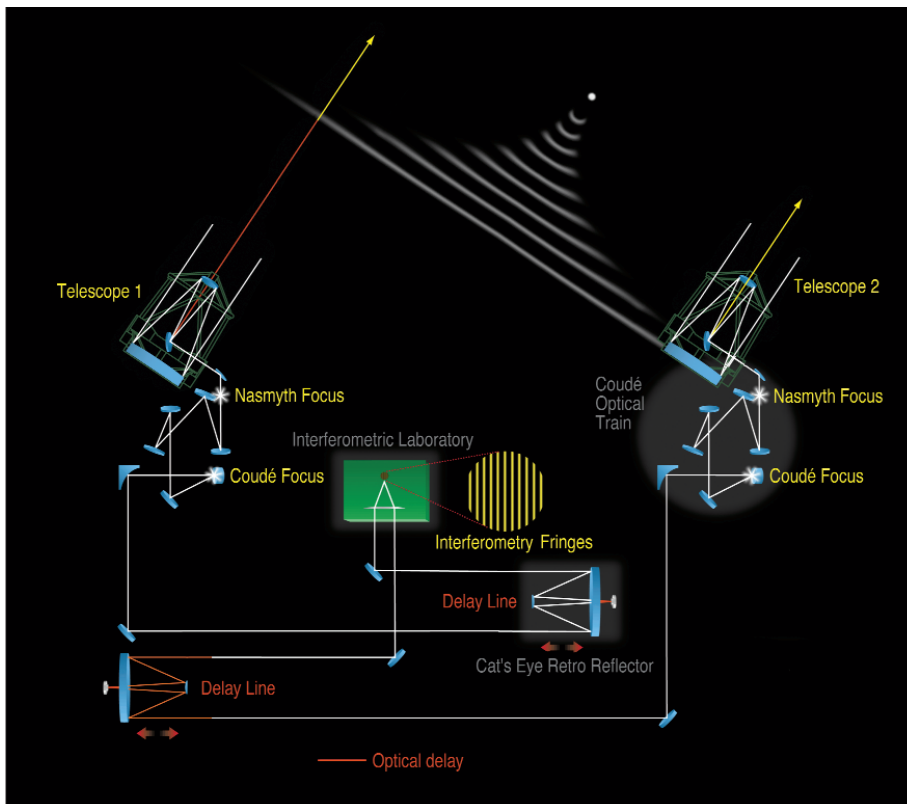
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Schematic overview of the VLT interferometer (© ESO).