Safe transport containers for SCHOTT telescope mirror substrate

The European Southern Observatory (ESO) is building the world’s largest optical telescope in the Chilean Atacama Desert. Its Extremely Large Telescope (ELT) is scheduled to go into operation in 2024. Made of ZERODUR® glass ceramic, SCHOTT mirror substrate will give a unique view of the stars. TECOSIM assisted in designing the special containers required to transport the substrate to Chile from Mainz in Germany.

CHALLENGE
SCHOTT is casting the mirror substrate in different sizes at its Mainz headquarters before shipping it to a location near Paris. There, a specialised company grinds and polishes the glass surfaces to an accuracy of 15 nanometres. The substrate is then forwarded to Chile by ship and heavy haulage carrier. Consequently, the required transport containers needed to be designed for an extensive range of potential load impacts at sea and on the road.

SOLUTION
TECOSIM assisted with the transport container design, helping to ensure sturdy, secure transport for the mirror substrates. The TECOSIM experts calculated and simulated different potential imposed loads, such as those experienced during shipping and road transport. Sudden swaying motions during crane handling or potential earthquakes were also included in calculations. FE calculations enabled the company to recommend efficient solutions in the selection of container materials.
TECOSIM SERVICES
Calculating structural loads
First of all, TECOSIM took into account the static loads for transport by road and on a ship. The engineers then used these results to calculate swaying stability during earthquakes and crane loading. In doing so, they not only included the container, but also isolated the lid, including the lock mechanism, in calculations. The developed structure guarantees exceptionally high impact resistance.

Design to absorb dynamic loads
The mirror substrate’s large mass may cause momentum in the transport system, which increases the risk of damage to the glass ceramics. Special elastomer dampers and coil springs in the transport container have been designed to ensure break-proof transportation. The container must be able to absorb inertia when under load. The CAE specialists used a random response analysis to simulate the dynamic loads through a transport-specific acceleration range. The very low load results during vertical and horizontal excitation revealed an excellent absorption effect in the transport container. This means damage to the mirror substrate can be ruled out.

Inclusion of thermal loads
The Extremely Large Telescope (ELT) is being constructed on the Cerro Armazones, a mountain over 3,000 metres high in Chile’s Atacama Desert. That is why TECOSIM also included heating due to sunlight and consequential material stresses in its simulation and design for the transport container.

CUSTOMER BENEFIT
TECOSIM assisted SCHOTT in the challenging task of developing containers for safe transport of the mirror substrates. The engineers achieved outstanding stability in the structure that they developed for specific static, dynamic and thermal loads. This ensures extremely safe transport.

PROJECT DESCRIPTION
- Static and dynamic loads in mirror transport containers
- Calculation and simulation of different load cases
- Consideration of complex requirements for components
- FE calculations to select material quality grades and thickness widths

RESULTS
- Guaranteed safe transport when exposed to different static and dynamic loads
- Guaranteed impact resistance during the loading process
- Assured operational capability under thermal load
- Optimisation of stability thanks to design adjustments based on FE calculations

TECOSIM COMPANY PROFILE
With some 500 employees, TECOSIM is a highly capable partner for development processes and a specialist in computer-aided engineering (CAE). The internationally active group is represented by seven branches in Germany as well as its own locations in Japan, India, the UK and Austria. TECOSIM provides support for clients in the transport, energy, health care and industry sectors. Its engineers work on challenging tasks in design, construction, simulation, electronics and software development. Process optimisation methods complement the range of services.

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The new 5-mirror optical system on the ESO Extremely Large Telescope (ELT) and the position of the ZERODUR® mirror supports. The telescope comprises a large main mirror (M1) consisting of 798 hexagons and four smaller mirrors (M2 to M5) used as reflectors.