# A GTS series linear stage is behind the world's biggest eye on the sky: the world's toughest metrology project E-ELT

Newport GTS Series High Precision Linear Stages are used in one of the most difficult metrology challenges in the world today.

The European Extremely Large Telescope (E-ELT) will be the largest optical and infrared telescope ever built upon its completion. Scientists and engineers from all European countries have been collaborating on development of the telescope and full construction work is about to begin by European Southern Observatory (ESO). With an optical mirror that is over 39 meters in diameter, the area of mirror surface is larger than the combined reflecting area of all the major research telescopes currently in existence.

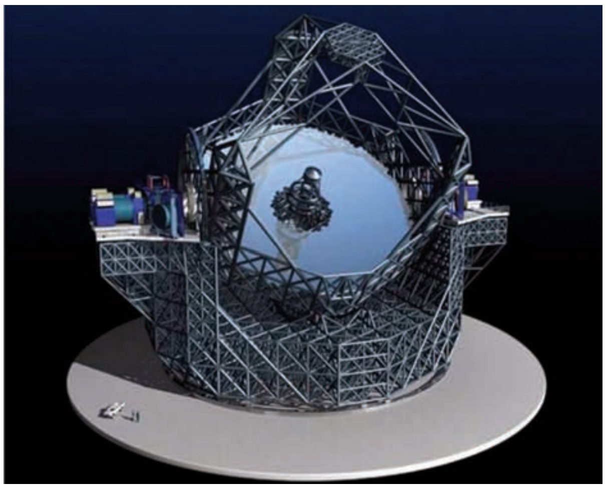

*Figure 1: A design concept image of the European Extremely Large Telescope by ESO (Europe Southern Observatory)*

The large primary mirror will be composed of 798 hexagonal segments, each with approximately 1.5 meters of corner-to-corner length. The long manufacture time of mirror segments (typically requiring 6 to 12 months) became a challenge during the feasibility study of the telescope. In order to manufacture these mirrors at a rate of one every other day, the reduced production time was critical and thus efficiency in line integrated metrology during the automated manufacturing process was the key to the success of the E-ELT project.

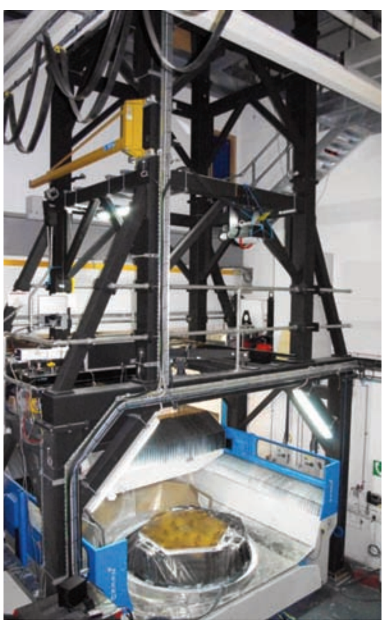

*Figure 2: Optical Mirror Polishing Tower for the E-ELT (Courtesy of OpTIC Glyndwr Ltd and Glyndwr University)*

In the final development process of the optical mirror prototype, Newport GTS series high precision linear stages performed a key role in an interferometer setup integrated within the large polishing tower shown in figure 2. Integration of the optical test tower in the polishing machine (the base of the tower in figure 2) allows performing metrology on the optical mirror in various stages of polishing, eliminating the need to remove the mirror from the polisher, ultimately increasing throughput and lowering the risk of detrimental surface variations.

The first mirror produced is used as the master reference that all subsequent mirrors are measured against. A measured surface roughness of this reference mirror is 1.6 nm rms and the form error is less than 17 nm rms over the optical clear aperture. This remarkable surface quality of the mirror is analogous to a straight line between London and New York with a ripple wave of less than 6.3mm (0.25 inch) in height along its entire length.

Due to the significantly long optical path length of the interferometer, which is approximately 35 meters, the Newport GTS stages are specifically selected after the manufacture, to provide superior flatness and straightness and less than 20 µrad in both pitch and yaw specifications. The stages provide small adjustments to correct for the principal aberrations during the metrology of a single primary mirror segment. A custom RG series optical breadboard provides an ideal platform for the GTS stage, with top and bottom skins manufactured from a single batch of steel to help eliminate bi-metallic heating effects.

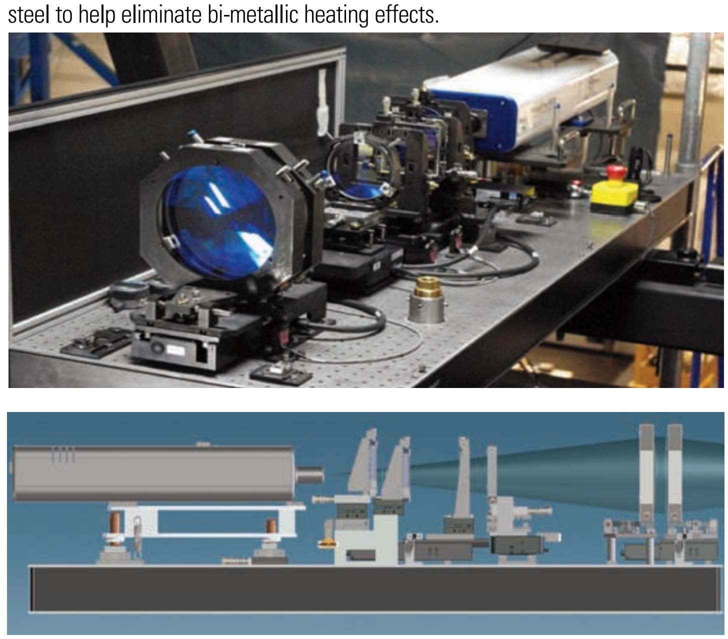

*Figure 3: A photo and schematic of interferometer setup with Newport GTS series linear stage (a courtesy of OpTIC Glyndwr Ltd and Glyndwr University)*

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High sensitivity and repeatability were also of key importance in selecting the GTS stages. The 50 nm resolution provided by a linear scale encoder, 100 nm incremental motion capability and 200nm bi-directional repeatability combined with superior angular run-out errors helped meet the stringent control requirements and budget constraints. An XPS series universal motion controller enabled complete integration and remote control of the tower through Ethernet communication in LabVIEW program environment.

With the operation planned to start early in the next decade, the E-ELT will help explore the universe as the largest ground based telescope. It will allow astronomers to pier deep into space, discover earth-like habitable planets, perform stellar archaeology in nearby galaxies and probe the nature of dark matter and energy. Working closely with scientists in this revolutionary work, Newport motion products will continue to play a vital role in addressing the questions about the universe, by solving one of the most challenging metrology tasks in the world today.

For more information, please contact Newport sales and applications engineers.

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