DOI: 10.18727/0722-6691/5346

The Rise of the Giant: ESO's Extremely Large Telescope

Michele Cirasuolo[1]
Roberto Tamai[1]
Bertrand Koehler[1]
Fabio Biancat-Marchet[1]
Juan-Carlos Gonzáles Herrera[1]
and the ELT Team

[1] ESO

The European Southern Observatory's Extremely Large Telescope (ESO's ELT) stands as the cornerstone of ESO's ambitious vision to build a new facility capable of providing a paradigm shift in our understanding of the cosmos. ESO's ELT is swiftly advancing towards completion, having surpassed, in June 2023, the 50% completion milestone. Possessing unparalleled sensitivity and angular resolution thanks to its 39-metre main mirror, ESO's ELT holds the potential to revolutionise our perspective on the Universe, from the exploration of exoplanets to the detailed study of stellar populations, and from unravelling the mysteries of galaxy evolution to probing fundamental physics and cosmology.

Brief overview

ESO's Extremely Large Telescope (or the ELT) will be housed in a giant 92-metre-diameter dome, which will provide protection from the environment of Chile's Atacama Desert. The main structure of the telescope will hold its five mirrors and optics, including the enormous 39-metre primary mirror made of 798 individual segments. The ELT will be also equipped with cutting-edge instruments, designed to cover a wide range of scientific possibilities, analysing light by means of imaging and spectroscopy. Both telescope and instruments will employ sophisticated adaptive optics technologies to compensate for the turbulence of Earth's atmosphere and to ensure the sharpest images, some six times sharper than the James Webb Space Telescope can produce.

Progress

The construction of this technically complex project has reached a key milestone, now surpassing the halfway mark as estimated by Earned Value Analysis, i.e. comparing the progress achieved and actual deliverables to the overall baseline plan[1].

As described in detail by Pascal Martinez in this issue of The Messenger (p. 4), the assembly of the dome structure, with its familiar round shape, is almost completed and is now clearly visible on top of Cerro Armazones in the Chilean Andes; inside it, the telescope structure is taking shape. What has been for many years the domain of 'artist's impressions' is now a reality and progress can be followed via dedicated webcams on the ELT website[2].

The other area where huge progress has been made is the production of the optics, as described by Elise Vernet et al., also in this issue of The Messenger (p. 6). The manufacturing in Europe of the various optics subsystems is advancing at a staggering pace. More than 90% of the blanks and the related supports needed to assemble the 798 hexagonal segments that form the giant primary mirror (M1) have now been manufactured. The first 100 fully assembled and polished segments have been completed, reaching a surface quality better than specification at a few tens of nanometers (almost 5000 times smaller than a human hair), and the first 18 segments have already reached Chile[3]. Both the secondary (M2) and tertiary (M3) mirrors, each with a diameter of ~ 4 metres, have already been cast, M2 having almost completed the polishing process, and the mechanical cells that will hold the mirrors in place are in their final stages of production. The M4 and M5 mirrors that are at the core of the telescope's adaptive optics, capable of moving and adjusting their shape a thousand times a second to correct for distortions caused by air turbulence, are also in full production. And all six laser sources, another key component of the ELT's adaptive optics system, have been produced and delivered to ESO for testing.

The development and production of other crucial operational systems, such as the control system, the pre-focal stations and the assembly equipment for the ELT, are also progressing well, while the support infrastructure at Cerro Armazones and Paranal, including the technical building for mirror storage and coating and the photovoltaic plant, are already in full operation. In parallel to all this progress, the organisation has also set up an On-Site Engineering Department to provide, within the best matrix approach, the required resources for the final Assembly Integration and Verification phase.

As regards the instrumentation that will allow scientists to analyse the light collected by the telescope coming from distant planets, stars and galaxies, all four instruments — the Multi-AO Imaging Camera for Deep Observations (MICADO), the High Angular Resolution Monolithic Optical and Near-infrared Integral field spectrograph (HARMONI), the Mid-infrared ELT Imager and Spectrograph (METIS) and the Multiconjugate adaptive Optics Relay For ELT Observations (MORFEO) — are now in their final design phases, and manufacturing of some key components has already started. At the same time, the future instruments the ArmazoNes high Dispersion Echelle Spectrograph (ANDES) and the multi-object spectrograph MOSAIC have started their preliminary design.

Completion and first light

While the journey to reach this halfway point has been marked by meticulous design finalisation, prototyping, and extensive testing campaigns, and also hindered by the challenges posed by the COVID-19 pandemic when the site and many production lines closed for several months, the timescale to complete the remaining 50% of the project is estimated to be shorter. Indeed, all production processes are now fully operational and running at full speed, while the planning for the final integration of all the subsystems to assemble and commission the telescope is in place. In just a few years, in 2028, ESO's ELT is expected to start scientific observations, and with its 'biggest eye on the sky' it is poised to unravel profound mysteries of the Universe and our place within it.

Links

[1] ESO press release "ESO's Extremely Large Telescope is now half completed": https://www.eso.org/public/news/eso2310/
[2] ELT webcams: https://elt.eso.org/about/webcams/
[3] ESO press release "First segments of the world's largest telescope mirror shipped to Chile": https://www.eso.org/public/news/eso2319/