The science and technology of the E-ELT

Roberto Gilmozzi, ESO

The 39 meter European Extremely Large Telescope (E-ELT) programme has successfully passed various design and cost reviews and has been approved by the ESO Council in June 2012. Current commitments stand at 60% of the total cost, with most of the remaining funding expected after the Brazilian parliament has ratified its accession agreement. Construction will start when 90% of the cost has been pledged, and will take about 10 years.

Construction activities have started, however: the contract for the construction of a road to the summit of Cerro Armazones, the levelling of the top of the mountain and additional civil works has been signed last December while another contract, for the preliminary design of the E-ELT adaptive mirror, has been running for almost two years. It is expected that other contracts will be let before the end of the year.

The E-ELT is an adaptive telescope based on a novel 5-mirror design composed of a 39-m segmented primary (798 segments), a 4-m convex secondary, a 4.2-m tertiary and two flat mirrors, an adaptive M4 (2.5-m) and tip-tilt M5 (2.4-m x 3-m), which correct for the effects of atmospheric turbulence. A 73-m high, 82-m wide dome protects the telescope from the elements, and during the day its powerful air conditioning system maintains the telescope and mirrors at the temperature expected for the night (to avoid local turbulence generated by temperature gradients). All the major elements of telescope and dome went through competitive Front End Engineering Designs (FEEDs) during the phase B of the E-ELT design. FEEDs provide a design, its detailed specifications, a schedule and a binding firm fixed price offer to build (valid one year), substantially increasing the level of confidence of the total cost estimate.

The science case driving the technical specifications ranges from imaging and spectroscopy of extrasolar planets, including the search for biomarkers in earth analogs, to resolved stellar populations out to nearby clusters of galaxies and in objects inaccessible today (i.e. ellipticals); from the direct determination of the acceleration in the expansion of the Universe (using a dynamical rather than geometric method) to the study of the first stars and galaxies. And of course the opening of new parameter space bodes well for the possibility of new discoveries (the jump in diameter between the E-ELT and the current generation of telescopes is of the same order as that between the naked eye and Galileo's telescope).

A suite of instruments to execute the E-ELT science case has been studied together with the astronomical community during the telescope phase B. Two first light instruments have been selected (a diffraction limit near IR imager with a ~ 1x1 arcmin^2 field of view and an integral field spectrograph working in the optical and near IR both with and without adaptive optics correction). The third planned instrument is a mid infrared imager and spectrograph working at the diffraction limit. The instruments beyond first light will include a multi object spectrograph, a high resolution spectrograph and an extreme adaptive optics exoplanet characterization instrument. Their sequence will be dictated by technology readiness reviews and one of them is expected to arrive at the telescope roughly every two years. Opportunities to propose further instruments are also foreseen.

Given the E-ELT's high angular resolution, unprecedented depth, and wavelength domain (optical to mid IR), I would expect the FISICA and E-ELT science to be highly complementary.