# 1. Scope



This document presents the conceptual design study undertaken by ESO to assess the feasibility of building a 100-m class optical and near-infrared extremely large telescope – called OWL. It contains detailed studies of the key subsystems as well as proposed project implementations and engineering solutions. While recognizing that any modern observatory is an integrated system of telescope, instruments, data, operations and communications subsystems, this study chooses to focus on the technical feasibility and associated costs of the major subsystems of a particular design approach that meets a set of science cases appropriate to a 100-m class facility.

The OWL system is still in a highly dynamic design phase, and the completion of the conceptual design of all subsystems does not entail irreversible design decisions. Indeed, the proposed design phases have been scheduled in a manner that allows requirements to be iterated and design options to be pursued well into the overall design process. In particular, the modular opto-mechanical concept makes it possible to consider relatively fast and significant reconfigurations. This flexibility would clearly only exist if the eventual telescope size falls within a range (~60-m to ~120-m) compatible with modular design and extensive parallelization of supply, integration and maintenance lines. Notwithstanding possible changes of major requirements, the ensuing preliminary design phase would start with a re-assessment of the current opto-mechanical design with a view to incorporating feedback from recent instrument studies. For evident reasons, the latter could only be initiated after defining a plausible telescope design to a reasonable level of detail.

Chapter 2 of this document provides a broad overview of the OWL concept, preliminary conclusions and possible plans including summary reports on related activities. In particular, these reports cover the generic development of enabling technologies undertaken by an ESO lead collaboration of 27 partners, including industry, with financial support by the European Commission (Framework Programme 6, ELT Design Study).

Chapter 3 is a brief summary of the science case, addressed in more details elsewhere (RD526) in the general context of Extremely Large Telescopes.

Chapter 4 provides the subsequent top-level scientific and technical requirements. It is well understood that the design, construction and operation of a system the size and complexity of OWL requires more than technical feasibility of its subsystems. Chapter 5 provides an overview of the proposed System Engineering approach, including methods, tools and essential parameters. Chapters 6 to 13 provide a relatively detailed description of the design and underlying analysis. Some areas are addressed in more detail than others, in particular where separate, supporting reports were not available in time for this review. To a more limited extent, the same applies to Chapter 14, devoted to site considerations.

Observatory and science operations are briefly addressed in Chapter 15. Management aspects, including plans, schedule and cost estimates are provided in Chapter 16. Roughly 70% of the estimated capital investment (e.g. segments, telescope structure, enclosure) are supported by industrial studies undertaken by experienced suppliers under ESO contract. The remaining 30% are either internal estimates or, in the case of adaptive optics subsystems, (generous) allocations. At the time of writing of this document, further industrial studies are under way or planned. It is anticipated that the ensuing preliminary design phase would include extensive interaction with industrial suppliers, with a view not only to consolidating design solutions and exploring alternative ones, but also to strengthening confidence in the eventual schedule and cost. A summary table of the baseline design characteristics is provided towards the end of this document.

Maximum and reliable scientific capability, as well as constant awareness of requirements, of design, production, integration and operation constraints, including engineering, cost and schedule considerations, have played a major role in the development of OWL. They will continue to do so in the ensuing phases. The same applies to risk assessment and management. The number of degrees of freedom and the complexity of the control systems are challenging enough. Wherever possible, the OWL design is tailored to minimize supply and technological risks, even with adaptive optics –the first generation adaptive mirror of OWL relies on the simplest optical form: a flat surface. Control schemes will be tested well before glass needs to be cast; the Multi-conjugate Adaptive Optics Demonstrator (MAD) is already being tested in the laboratory, with promising results. The development of generic technologies and concepts is proceeding with the ELT Design Study, gathering partners across European academia and industry under ESO's lead. Combined active optics and segmented mirror control will be tested on-sky with the Active Phasing Experiment. While OWL does indeed include overwhelming challenges, we believe that they can be managed – and that none of them taken individually may compare to the one originally taken with the VLT, when the fabrication of its most essential element -the primary mirror- was, perhaps, the most daring challenge taken up by the scientific community and by industry in decades of telescope-making.