The Arcetri-STILES: introducing two research facilities dedicated to problem solving for the ELTs.

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Abstract

Here we introduce two R&D facilities we are going to set up at the Arcetri Observatory premises. The framework is the "Strengthening the Italian leadership in ELT and SKA" (STILES) project and the goal is to deepen the knowledge of the next generation of adaptive optics systems on 40m-class telescopes by moving the experimentation from computer-based numerical simulations to the lab. STILES is funded by the "Piano Nazionale di Ripresa e Resilienza" (PNRR) within the Next Generation EU (NGEU) programme. This represents a unique occasion to provide the Arcetri Observatory with state of the art equipment allowing the international community to benefit from two cutting edge facilities that will be set up in the ADONI laboratory. These are the AoCascading and AoPetalometer test benches, the former dedicated to study the Extreme Adaptive Optics (XAO) technique for planet finding instruments at ELT and the latter dedicated to the solution of the piston control on the ELT segmented pupil.
In the first part of the paper we will introduce the scientific goals and objectives of the AoCascading experiment, giving also an overview of the layout of the test bench. Briefly, the detection and characterisation of exo-Earths requires a high level of Strehl and image contrast thus it is mandatory to provide planet finders with XAO systems. In the case of ELT this could be achieved by coupling a second deformable mirror in cascade to M4/M5. By implementing an optical relay with two DMs with a large number of actuators and two high-order pyramid WFS in cascade configuration, the AoCascading test bench will simulate in the lab all the aspects of the implementation and control of an XAO system at the ELT. The other test bench, the AoPetalometer, will be dedicated to experiment the most challenging aspect of the ELT control: the phasing of the 6 petals composing M4. Every instrument on ELT will need to control the differential piston between the M4 segments in order to preserve the coherence in the full aperture wavefront, exploiting the spatial resolution of the 39m pupil. Nowaday, the petalometer is an open challenge for the entire AO community working for ELT instruments. The AoPetalometer will implement an optical relay to simulate for the ELT-M4 layout and different wavefront sensors and phasing techniques in order to identify the best petalometer. This will be achieved by building a custom-made segmented mirror mimicking for the M4 petalas and a reference metrology system to validate the petalometer measurements.

Keywords: ELT, Extreme Adaptive Optics, planet finder, Piston error, Cophasing, M4, Petalometer

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