

WP6: Deformable mirrors and the EST-MCAO performance

Description

Work package number	WP6	Lead beneficiary	2 - INAF
Work package title	Deformable mirrors and the EST-MCAO performance		
Start month	1	End month	36

Objectives

- Investigate the effects of 45-degree inclined DMs in the performance of the EST/MCAO system.
- Feasibility study of the DMs proposed in the EST/MCAO.
- Implement techniques to reduce and correct the wavefront distortion at EST.
- Optimise the design of the EST/MCAO system

Description of work and role of partners

WP6 - Deformable mirrors and the EST-MCAO performance [Months: 1-36] (INAF, IAC, UNITOV, SU)

In order to achieve its objectives, WP6 will carry out numerical simulations, software development, and laboratory tests.

WP6 will study the effects of large tilt angle DMs with an elliptic pupil in the EST/MCAO performances by carrying out end-to-end numerical simulations of the system with software available to the project partners. The numerical simulations will make it possible the evaluation of the main error sources of the EST/DMs configuration. In addition, they will also provide a first evaluation of the tolerances of the system. More in depth, WP6 plans to estimate the tolerances to small misalignment errors in the orientation of the DM pupil with respect the WFS pattern in order

to identify the required alignment accuracy that maximises the system performances. Starting from the end-to-end simulations and their results, new numerical control methods will be developed to take into account for misalignment errors and the pupil elongation. Secondly, because of the 45-degree inclination of the DMs in the system, the conjugation height of the mirror depends on the position on the mirror itself. For this reason, a proper wavefront reconstruction scheme able to limit the unwanted effects of this will be studied and tested.

The end-to-end simulation code will be developed in IDL language by using the well-tested and freely available Optical Propagation library, which allows the easy integration of external codes into the same simulation environment. The main advantage of using an end-to-end simulation code is the ability of simulating non-linear effects which may play a significant role in the overall system performances. In addition, the well tested Zemax software and the CAOS code available to the partners will be also used to study the case of 45-degree inclined DMs of the EST/MCAO. These software tools have been already successfully employed by the partners in the study of the adaptive optics of the night-time Large Binocular Telescope (LBT) when used in conjunction with the forthcoming SHARK (System for coronagraphy with

High order Adaptive optics from R to K band for high contrast imaging and exoplanets search. The main advantage of using a combination of different codes is the resulting flexibility, which allows the simulation of different optical components in detail.

Within the simulation environment, the numerical methods (the DM control scheme) will be refined before being exported and applied to the control of a DM already available for the laboratory tests in closed loop conditions. This activity will imply the development of a custom control software DM interface, which will be realised using the Labview language. Different numerical control schemes will then be tested in the laboratory to evaluate their performances. More in detail, both a modal and zonal control schemes will be tested in 45-degree inclined DMs. The results of these studies will be of paramount importance for the refinement of the MCAO system of EST and will eventually provide important information for the realization of custom DMs with a distribution of actuators that properly samples the wavefront.

WP6 will include the following tasks:

- Definition of study and test procedures. Definition of evaluation criteria.
- Numerical simulation setup.
- Numerical study. Analysis on the effects of 45-degree inclined DMs on the EST/MCAO performances and wavefront reconstruction. Assessment of the pupil rotation tolerances and detailed information for the realization of custom DMs with a non-circular distribution of actuators.
- Design of the laboratory tests.
- Laboratory setup.

- Study and development of the control software and interfaces for testing the performances of 45-degree inclined DMs.
- Study and laboratory tests of wavefront reconstruction with 45-degree inclined DMs.
- Study and laboratory tests of modal and zonal control schemes with 45-degree inclined DMs.
- Study of the technical feasibility of 45-degree inclined DMs with a distribution of actuators that properly samples the wavefront.
- Reporting.