
Development of test devices for the validation of MORFEO's reconstruction and control algorithms

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Abstract

The upcoming *Multi-conjugate adaptive Optics Relay For ELT Observations* (MORFEO) shows new and challenging issues, that need to be tested and prototyped before integration and troubleshooting on sky. One of the most critical aspects of this module is the reconstruction and control algorithm. To overcome the problem of *unseen modes*, MORFEO will implement a Minimum-Mean-Square-Estimator (MMSE) tomographic reconstructor, based on an *a priori* estimation of turbulence and noise statistics, that will be included in a Pseudo-Open Loop Control (POLC).

In this work, we aim at analyzing and testing the reconstruction and control algorithms foreseen for MORFEO through a simplified single-conjugated adaptive optics system test-bed and a numerical simulator. The optical setup includes a Shack-Hartmann Wavefront Sensor (SH-WFS) to sense the wavefront aberrations, a Spatial Light Modulator (SLM) to inject and also compensate for the disturbances and a scientific camera to analyze the correction performance through the Point Spread Function. In order to simulate MORFEO's wide field, we compute the projection of the atmospheric turbulent volume along the line of sight of each of the nine WFSs of MORFEO, then we apply it on the SLM and measure it through the SH-WFS. The measurements from all the directions are used to compute the tomographic reconstructor and, consequently, to infer the commands to the SLM. The whole process is reiterated by shifting the phase maps previously simulated, in order to take into account the temporal evolution effects between successive iterations of the control loop.

In this work, we show the current status of the test bench and the results of the first tests.

Keywords: MCAO, Atmospheric Turbulence, MMSE Tomographic Reconstructor, PLOC, Unseen Modes, Control Algorithms, Spatial Light Modulator, SH WFS, AO Simulation

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