Test Bed Systems for AO

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Purpose

The aim of this paper is to demonstrate the usefulness of having a well calibrated test-bed that allows to fully investigating the capabilities of an Adaptive Optics (AO) system or its components under very well controlled conditions.

Abstract

Adaptive Optics systems are complex and their performances can be hard to establish in field conditions. In addition trying to compare on equal footing different components or algorithms for inclusion in a final system is also a hard proposition. For all these reasons our group at the Naval Research Laboratory (NRL) has developed a test-bed that can be used to test both full AO systems and subcomponents. The test-bed is based on a Liquid Crystal Device (LCD) that can be easily programmed to generate wavefront profiles in a very accurate way. The current device is a Holoeye device with ~600X400 pixels and a refresh rate up to 33 Hz. These parameters are the hardware limits to the wavefront resolution that can be generated and the temporal evolution of such wavefronts. Of course newer devices are available that allow much higher spatial and temporal resolutions. The most important aspect of the test-bed is the ability of accurate calibration and thus the comparison between theoretical expectation and measured performances.

Results

An example of a computed wavefront, with respective Point Spread Function (PSF), an measured set is shown in Figure 1. The top left panel shows the computed wavefront that was then used to generate the phase screen on the LCD. The top right panel shows the calculated PSF. Finally the central bottom panel shows the measured PSF. Adjusting for the saturation on the CCD camera and the difference in noise floor between the computed PSF and the measured PSF we obtain an agreement between the two within 10%. This example shows that we can compare accurately the theoretical forecasts with the measured performances. This turns allows us to test in a very rigorous and predictable way our AO systems or subsystems. Currently the test-bed can test two corrective elements and two wavefront sensors simultaneously. We also have two LCDs that allow us to approximate a two phase screen system that we use for testing “thick” aberrations approximations.

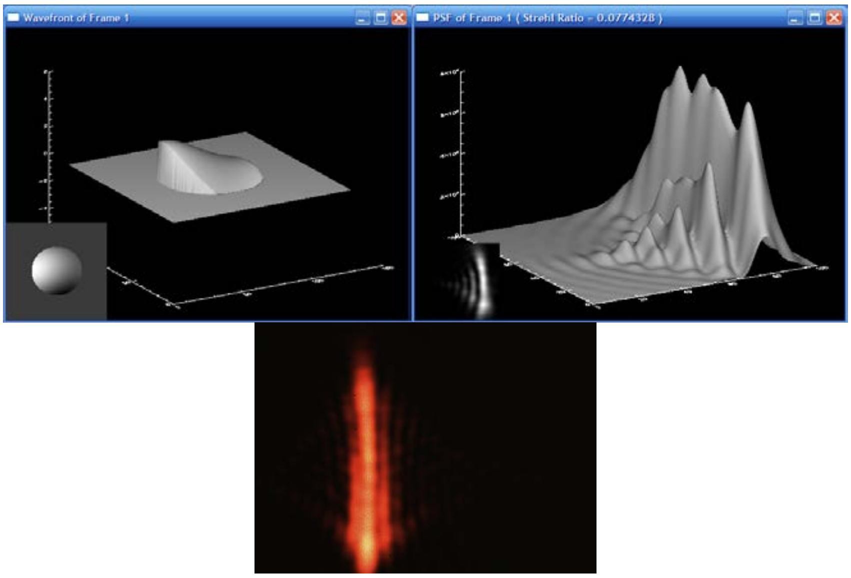

Fig. 1. Example of computed wavefront (top left), computed PSF (top right) and measured PSF (bootm center)

Conclusions

We have developed a flexible, inexpensive and easy to use test-bed that allows us to test AO systems and subsystems under controlled and repeatable conditions. We found that this approach is extremely useful in order to characterize the system before field experiments.