Advances with the WIVERN laboratory experiment for testing novel laser-based wavefront sensing techniques

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Abstract

WIVERN is a testbed for laboratory experiments in laser-based wavefront sensing. It emulates laser uplink from a 8m telescope with 0.8 arcsec seeing and laser back-scattering from up to 20 km.
Currently there are three wavefront sensing capabilities designed into the experiment. The first two are from a wide-field of view (1.0 arcmin) Shack Hartmann wavefront sensor observing a constellation of point sources at infinity (reference targets, for conventional, star-oriented wavefront sensing), or observing an image from emulated atmospheric Rayleigh/sodium back-scattering (for wide-field correlation wavefront sensing). The third is based on the PPPP concept. For both back-scattering experiments (correlation or PPPP) a laser beam can be launched from the pupil through the phase screens, scattered from a plane, and then returned through the pupil and onto the WFS.

For the correlation wavefront sensing, the signal is developed as with conventional LGS, on the return path to the telescope, using contrast in the projected pattern to detect motion. Meanwhile for PPPP, the beam projected is as wide as the pupil and the intensity distortions from wavefront propagation are produced on the outwards propagation, with back-scattering emulation simply to retrieve the signal back at the telescope.

Other sub-systems designed are the laser projection replicating a pupil launch, a 7x7 pupil-conjugate deformable mirror (DM), and a wide-field camera for PSF analysis. The SH WFS camera is a First Light C-Blue ONE which can measure images of 1100x1100 at upto _~500 Hz (using the DAO software, see the presentation by Cetre et al in this meeting for more information). This acquisition speed is only necessary for statistical and machine-learning analysis, but is useful for RTC development. Currently the DM is not installed and the system is used for wavefront-sensing experiments.

We report in this meeting our latest progress in the correlated wavefront sensing using a laser of low coherence which generates high-contrast speckles; this is used for the correlation analysis. The aim of WIVERN Is wide-field wavefront sensing and our results report on progress with enabling multiple sub-regions within each sub-aperture. We also discuss ideas for enabling the PPPP mode for which we've encountered unanticipated design issues.

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