Dynamic, optical gain compensation and phase unwrapping for the Zernike Wave-Front Sensor

Mahawa Cisse*[1], Vincent Chambouleyron[2], Olivier Fauvarque[3], Nicolas Levraud[4,5], Jean-Francois Sauvage[4], Charlotte Bond[6], Thierry Fusco[7], and Benoit Neichel[8]

[1]LAM – Le Laboratoire D'Astrophysique De Marseille – France
[2]Laboratoire d'Astrophysique de Marseille – Aix Marseille Université : UMR7326 – France
[3]Laboratoire Détection Capteurs et Mesures - REM/RDT/LDCM – Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER) – France
[4]ONERA, Université Paris Saclay [Châtillon] – ONERA : DOTA(HRA) – France
[5]INAF - Osservatorio Astrofisico di Arcetri – Italy
[6]UK Astronomy Technology Centre – United Kingdom
[7]ONERA – ONERA, ONERA – France
[8]Aix Marseille Université, CNRS, LAM – CNRS : UMR7326 – France

Abstract

Due to its high sensitivity, the Zernike Wave-Front Sensor (ZWFS) is a good candidate as a Wave-Front Sensor (WFS) for a second stage AO correction. In addition to it's high sensitivity the ZWFS is able to sense segment piston and therefore can strongly improve the AO performances for the the next generation of telescopes. However, due to its small dynamic range, its use as a second stage AO system will strongly depend on the performances of the first stage.
To overcome its small dynamic range, the computation of the optical gain (OG) is essential to deal with the non-linearities of the sensor. Another difficulty with using the ZWFS as a second stage sensor is the phase wrapping. Given that the ZWFS is a phase sensor, as soon as the phase exceeds (-pi;pi) , the ZWFS will provide a wrapped phase estimation. It then becomes necessary to unwrap the phase to enhance the accuracy of the estimation. However, the OG make the phase unwrapping challenging. It is therefore, crucial to have a correct estimation of the OG in order to obtain an accurate unwrapping. Estimating the OG will also improve the accuracy of the wavefront measurement.
We present here two different methods to compute the optical gain of the ZWFS, the phase unwrapping of the ZWFS signals and the simulated close-loop tests.

*Speaker