Study of the LIFT focal-plane wavefront sensor for GALACSI NFM

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Abstract

The Infrared Low Order Sensor (IRLOS) has recently been upgraded to increase the sky coverage of the Narrow-Field Mode (NFM) of VLT UT4's Adaptive Optics Facility (AOF). The current version of IRLOS uses a 2x2 Shack-Hartmann WaveFront Sensor (WFS) in the J+H band as a baseline solution for low-order wavefront sensing. However, a full-pupil mode of IRLOS was additionally proposed to address the faintest end of the magnitude range by concentrating photons from the full aperture into a single focal-plane Point Spread Function (PSF), avoiding the lenslet-induced flux division. In this context, we are studying the LInearized Focal-plane Technique (LIFT), a phase diversity-based wavefront sensing approach that enables the retrieval of low-order modes from a single closed-loop PSF image of a Natural Guide Star (NGS). We mainly examine this method within the scope of AOF. We analyze the linearity, sensitivity, and stability of LIFT in simulated, experimental, and on-sky scenarios and discuss the practical aspects and challenges of implementing this method as a part of real operations. Additionally, we examine the potential applicability of this technique for future-generation instruments of VLT and ELT, such as MAVIS and MORFEO+MICADO. These instruments will implement the Multi-Conjugate Adaptive Optics (MCAO) correction using multiple off-axis NGSs, that will be probed in a similar fashion to AOF's IRLOS, making LIFT potentially applicable in this case.

Keywords: Focal Plane Wavefront Sensing, Wavefront Sensing, Adaptive Optics, Machine Learning, LIFT, PSF Reconstruction, PSF

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