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MAVIS: How to ”LIFT” the sky coverage ?

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Summary

MAVIS (which stands for MCAO Assisted Visible Imager and Spectrograph) is a proposed instrument for the ESO's VLT Adaptive Optics Facility (AOF - UT4 Yepun). From the ESO's call which includes Top Level Requirements (TLRs), this instrument shall provide diffraction-limited images in the V-band to z-band on a 30 arcsec field of view, in the visible range, under seeing condition < 1 arcsec.
A very challenging aspect of these TLR, is the sky coverage that shall be at least 50% (TBC) of the pointings at the Galactic pole.

To satisfy the requirements, a Multi-Conjugate Adaptive Optics (MCAO) system is used. It is based on a tomographic reconstruction of the atmospheric turbulence phase volume associated to the involvement of several deformable mirrors, optically conjugated at different altitudes of the turbulent volume, that are stacked to perform a uniform 3D correction beyond the limitation of natural angular anisoplanatism. The tomographic reconstruction is performed using information provided by multiple guide stars (Natural NGS and Laser LGS). Two problems appear regarding LGS wavefront sensing. Firstly, LGS does not sense turbulence's Tip/Tilt modes. Secondly, there is an uncertainty regarding the LGS mean height, which corresponds to a focus error on the LGS wavefront sensing. Thus, the correction of these different aberrations has to be retrieved from the information given by three NGS infrared low order (Tip/Tilt/Focus) sensors. Three bright enough stars has to be found in a 120 arcsec diameter circle around the scientific field of view which drastically constrain the instrument sky coverage. Hence, MCAO instruments like MAVIS require very sensitive NGS low order WFS.

In order to reach the required sky coverage for MAVIS, the use of LIFT (Linearized Focal-Plane Technique) focal plane sensor, which is based on the concept of phase diversity, will be studied. Its linearity and sensitivity will be analyzed for low orders (Tip/Tilt/Focus). This technique is very well adapted in the MAVIS case where scientific performance is optimized in the VIS and the NGS wavefront sensing is made in the IR. Consequently, NGS will be very well corrected and LIFT could be use in its optimal regime (small phase approximation).

In this communication, we will compare in the MAVIS context LIFT and more classical Shack-Hartmann based WFSs. We will describe the specific adjustments and optimizations proposed with respect to the original LIFT concept in order to match the MAVIS specifications. Finally, we will demonstrate that LIFT low order NGS infrared wavefront sensing could be a way to "LIFT"the sky coverage of the MAVIS instrument.

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