Results from the Harmoni Laser Guide Star wavefront sensor prototype

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Abstract

HARMONI is the first light visible and near-IR integral field spectrograph for the ELT that will be on sky on 2029. To prepare the final design of the Laser Guide Star Sensors (LGSS), we have developed since few years a full scale prototype of the LGS wavefront sensors implemented in an optical bench to simulate the laser guide star and the turbulence. The WaveFront Sensor (WFS) is a classic Shack-Hartmann that has to sense the wavefront of an ELT (39m pupil diameter). Our prototype is composed of 80x80 double side microlens array, a 6 lenses optical relay to reimage the light coming from the microlens on the detector, and a CMOS camera using a SONY detector with 1608x1104 pixels, RON $<$ 3e- at a frame rate of 500Hz. The choice of the sensor has been motivated by the large number of pixels to provide a field of view larger than 15 arcsec per surbaperture. Our bench has the particularity to use a Spatial Light Modulator (SLM) to emulate the M4 deformable mirror (DM) and its actuators geometry and the atmospheric turbulence. We present our study of the wavefront sensing with this prototype: we show that there is no limitation to use a relay between the microlens array and the detector, the behaviour of the wavefront sensor is similar as more classic components. In addition, we present our implementation of elongated laser spots on the bench. They are used to better understand the effect of elongated and truncated spots on the wavefront sensing (possible presence of bias, impact of stray light, wavefront sensing algorithm on elongated spots, etc). The bench is implemented to mimic the HARMONI LGS AO loop and to validate and optimise the algorithms that will be used on the instrument, in particular the super-resolution concept.

Keywords: ELT, Harmoni, Lasr Guide Star Sensors, elongated spots, SLM

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