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THE SEGMENTED PUPIL EXPERIMENT FOR EXOPLANET DETECTION (SPEED). ADVANCES AND FIRST LIGHT WITH SEGMENTS COPHASING

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Abstract. We present in this paper the latest news about the integration of the optical path of the SPEED bench, especially the first results obtained using the SCC-PS, a cophasing tool developed at Laboratoire Lagrange.

Keywords: Cophasing, Giant Segmented Telescopes, wavefront sensor, phase measurement, high contrast imaging

1 Introduction

SPEED (Segmented Pupil Experiment for Exoplanet Detection) is an instrumental test-bed designed to offer an ideal cocoon to provide relevant solutions in both cophasing and high-contrast imaging with segmented telescopes. The next generation of observatories will be made of a primary mirror with excessive complexity (mirror segmentation, central obscuration, and spider vanes) undoubtedly known to be unfavorable for the direct detection of exoplanets. Exoplanets detection around late-type stars (M-dwarfs) constitutes an outstanding reservoir of candidates, and SPEED integrates all the recipes to pave the road for this science case (cophasing sensors, multi-DM wavefront control and shaping architecture, and advanced coronagraphy). In this paper, we provide the latest news regarding the first light with segments cophasing control and monitoring from a coronagraphic image. The complete description of the bench can be found in Martinez et al. (2018) and the description of the cophasing sensors can be found in Janin-Potiron et al. (2016, 2017).

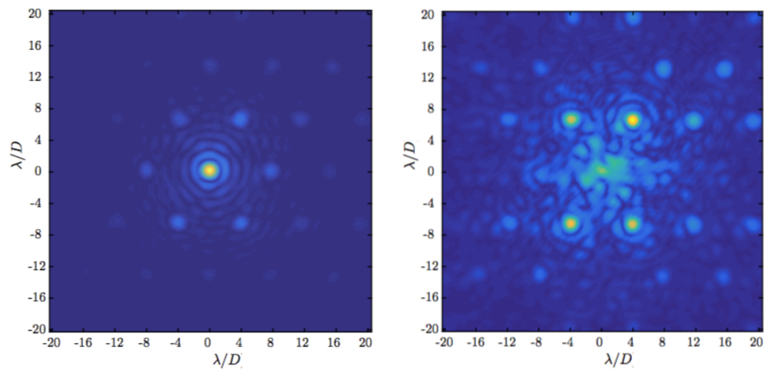

Fig. 1. Left: off-axis coronagraphic PSF measured on the optical path. **Right:** on-axis coronagraphic PSF measured after the FQPM coronagraph. The fringes pattern is produced by the SCC-PS.

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2 Optical path first light

This section will be mainly composed with images from the SPEED bench. Short comments will be given for each. The full description can be found in Janin-Potiron (2017).

We first measured PSF from the optical path, one off-axis (i.e. without the coronagraph, see Fig. 1, left) and on on-axis (i.e. with the coronagraph, see Fig. 1, right). On both images, diffraction structures produced by the hexagonal geometry of the segmented mirror are clearly visible. On the coronagraphic image, fringes are present on the speckles due to the SCC-PS system. From these fringes we are able to retrieve the phase information of the cophasing errors of piston, tip and tilt.

Once the system produced good quality images, we measured the response of the cophasing sensor to the piston and tip-tilt aberrations on the central segment of the mirror. The measurement of the piston estimator called φ_0 is shown on Fig.2 (left). It is periodic as expected. On the same figure (right), we present the estimated phase on the pupil when a piston is applied on the central segment.

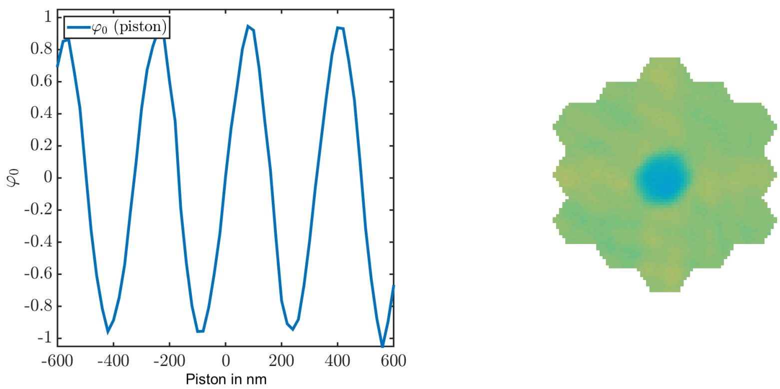

Fig. 2. Left: off-axis coronagraphic PSF measured on the optical path. **Right:** on-axis coronagraphic PSF measured after the FQPM coronagraph. The fringes pattern is produced by the SCC-PS.

Finally, we were able to take a calibration matrix for the whole system in piston, tip and tilt. The matrix is presented on Fig.3. It is a diagonal dominant matrix. The piston, and tip-tilt signal have not been rescaled and this explains the difference in term of amplitude in the matrix. On the same figure on the right, we see the segmented pupil we one tilted segment.

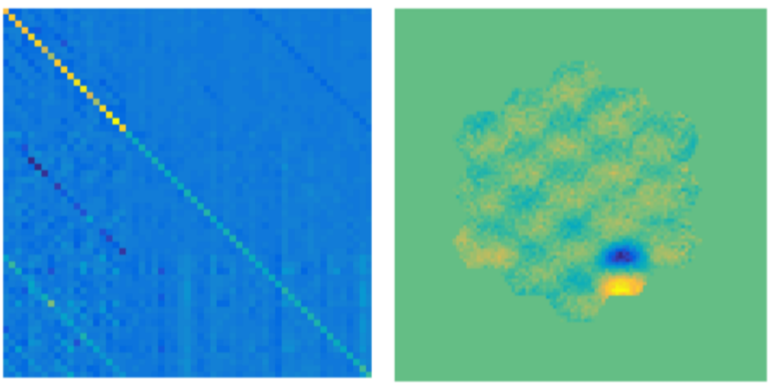

Fig. 3. Left: off-axis coronagraphic PSF measured on the optical path. **Right:** on-axis coronagraphic PSF measured after the FQPM coronagraph. The fringes pattern is produced by the SCC-PS.

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