GPI2.0: Implementing a Zernike wavefront sensor for Non-Common Path Aberrations measurement.

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Abstract

Gemini Planet Imager is a high-contrast "planet hunter" instrument installed on Gemini South telescope in 2014. After 6 years of operation, it is now going through a set of upgrades before being moved to Gemini North (commissioning expected in 2024). The upgrades will include: (i) an EMCCD pyramid wavefront sensor (WFS) to push performance limits of the extreme adaptive optics system (ii) new coronagraph designs (iii) new observing modes for the Integral-Field-Spectrograph.
One large limitation of this kind of instrument is the quasi-static non-common path aberrations (NCPA) between the WFS and the science paths. To measure these NCPA, we propose to implement a Zernike wavefront sensor (ZWFS) in the system: a reflective Zernike phase mask will be placed in the focal plane masks wheel of the coronagraphic setup and the wavefront detection will be performed by a pupil imaging branch (FLI/Cred-2 camera) already installed on the previous version of GPI (see Figure below). Thanks to high-sensitivity of the ZWFS, this setup will allow us to measure the NCPA in a limited amount of time before each observation run.
After presenting the overall strategy for NCPA measurements, we discuss the main motivations that drove the ZWFS parameters: dimple size, phase-shift, wavelength, and bandwidth. One peculiarity of the GPI2.0 setup is that the ZWFS will routinely work with upstream coronagraphic amplitude apodizers. We will present end-to-end simulations of expected performances comparing different reconstruction techniques and results of on-going tests on the SEAL adaptive optics testbed at UCSC.

Keywords: Zernike wavefront sensor, High, contrast imaging, NCPA

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