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Fine phasing of the Giant Magellan Telescope in closed loop

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The Giant Magellan Telescope Organization (GMTO) and the Adaptive Optics (AO) team of Arcetri have been collaborating in the last decade to design the Natural guide star Wavefront Sensor (NGWS) for the Natural Guide Star AO mode of the GMT. The GMT's primary and deformable secondary mirror are each composed of 7 segments, and a critical task of the NGWS will be to keep these 7 segments in phase in addition to the classical AO correction. The baseline defined several years ago has two pyramid wavefront sensors working in the visible. The first one is used to close the AO loop (main channel), but it is not sensitive to differential pistons that are multiples of its central wavelength (lambda1), leading to segment ejections. The second pyramid, sensing at a slightly higher wavelength, is then used as a slow "truth sensor"(2nd channel) to derive the sign of a segment ejection and correct it by steps of lambda1. However, the robustness of this solution with respect to noise and turbulence conditions is not satisfying.
We are now in a prototyping phase, for which the first step is to improve the baseline or find an alternative design for the 2nd channel in order to gain robustness. We present this study, based on three potential sensing solutions: the pyramid, the Zernike phase contrast and focal-plane sensing with LIFT. We also report on a few lessons learned on differential piston sensing that might be of interest for systems facing issues with the so-called island effect and/or low-wind effect.

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