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# Integration and first tests of the Natural Guide Star Wavefront Sensor Prototype for GMT

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## Abstract

The Giant Magellan telescope adaptive optics system will use two different diffraction-limited imaging modes. One of them is the Natural Guide Star Adaptive Optics mode (NGAO). The NGAO features a single conjugate natural guide star to measure wavefront while using the seven deformable secondaries and a post focal wavefront sensor called the Natural Guide Star Wavefront Sensor NGWS. The NGWS sensor has two different channels: the main one featuring a high spatial sampling pyramid sensor dedicated to the fast frame rate correction of atmospheric turbulence and the second dedicated to the correct phasing of the seven segments of the GMT telescope. The Arcetri AO group, in collaboration with the GMTO and the University of Arizona, is in charge of providing the design, fabrication and test of the pyramid wavefront sensor channel of the NGWS prototype that will replicate all aspects of optical sensitivity including optical design, camera selection and data reduction. The NGWS prototype passed its Design Review in May 2022 and is now being integrated in preparation for shipment to the University of Arizona where it will be integrated (pyramid and phasing channel) and validation-tested in the High Contrast Adaptive Optics Testbed (HCAT) in late summer 2023. The test bench at the Arcetri Observatory features a deformable mirror and thus offers the possibility to close an AO loop and measure the sensitivity of the pyramid sensor. This paper reports on the integration and alignment of the main channel of the prototype as well as the preliminary tests performed at Arcetri.

**Keywords:** Giant Magellan Telescope, Pyramid Wavefront Sensor, Adaptive Optics, Prototype, Natural Guide Star

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