Phasing of telescope mirror segments using a fast, two-wavelength interferometer.

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Abstract: We demonstrate the combination of two-wavelength interferometry with an instantaneous phase-shift interferometer to achieve a measurement range greater than 10 mm and a resolution of a few nanometers with a single instrument. Results of measuring and phasing two mirror array segments are presented. The operational limits, calibration and accuracies of the technique are discussed.
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Summary

The testing of segmented primary telescope mirrors requires the measurement of potentially large step discontinuities between segments (millimeters) and at the same time requires high resolution (nanometers) to verify surface figure of the elements. In addition, the difficulty of vibrationally isolating large meter-class optics requires a measurement technique that is highly immune to vibration. In this paper we present results from a measurement system that combines instantaneous phase-shift interferometry with two-wavelength interferometry. A unique algorithm is used to combine the results of a differential phasemap computed from multiple-wavelength data and an absolute phasemap computed from single wavelength data to achieve very large dynamic range measurements. The system achieves a measurement range of centimeters and a resolution of a few nanometers with an acquisition time of less than 100 microseconds.

We have demonstrated a further capability of the fast multi-wavelength measurement by measuring both polished and ground substrates at the same time. Figure 1 shows measurements from a stack of aluminum substrates that are approximately 0.7mm thick. The top substrate is a roughly ground surface, while the bottom two are at different stages of polish. The single color interferogram shows tilt and surface quality of the two polished substrates but shows only random phase for the surface of the ground disk and does not resolve the step height discontinuities between the elements. The two-color phasemap clearly resolves the step height ambiguity between all three types of substrates.