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Alignment and mode mismatch sensing for higher-order Hermite-Gauss modes in interferometric gravitational wave detectors[1] LIU TAO, PAUL FULDA, ANNA GREEN, University of Florida, JESSICA KELLEY-DERZON, Skidmore College — Higher-order Hermite-Gauss (HG) laser modes offer thermal noise advantages over the fundamental mode in interferometric gravitational wave detectors such as Advanced LIGO. These interferometers must however be aligned to a high precision in order to achieve the optimal sensitivity. Preliminary studies have shown that misalignment and mode mismatch tolerances for higher order HG modes are tighter than for the fundamental mode, in the sense that the misalignment and mode mismatch induced power coupling losses scale linearly and quadratically with the mode order respectively. However, we studied by analytical and simulation methods the alignment and mode mismatch sensing for higher-order HG modes in both the traditional wavefront sensing (WFS) schemes and the more recent radio frequency jitter and lens modulation (RFJ/L) schemes. We report higher-order HG modes have stronger alignment and mode mismatch sensing error signals. In particular the RFJ/L schemes show an increase in the sensing gain that exactly matches the decrease in the corresponding tolerance. This potentially eliminates the downside of using higher-order HG modes with respect to their suffering from excessive misalignment and mode-mismatch induced power losses.

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