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Design and Alignment of Compact Optical Heads for Test Mass Readout with Deep-Frequency Modulation

Improving the low-frequency range (1 - 10 Hz) of ground-based detectors requires compact interferometric sensors with high displacement sensitivity and dynamic. We combine Deep frequency modulation and compact interferometric techniques to develop a sensor for local test mass readout. We introduce an optical head design with on-axis beam topology realized in a Quasi-Monolithic component (QMC) comprised of cube beam splitters, which ensures beam transmission through perpendicular surfaces to keep angular alignment constant when operated in air or vacuum. This On-axis beam propagation should enable sub-picometer level displacement sensing and nano-radian tilt sensing with a high displacement range. We implemented and investigated a table-top model of the QMC achieving high contrast values. The beam propagation and polarization effects in the QMC are analyzed and we present our current design for an integrated sensor.

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