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A testbed for Tilt-To-Length coupling and Differential-Wavefront-Sensing performance in LISA

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The LISA mission, which has been accepted by ESA as the ESA-L3 Gravitational Wave Mission, aims at measuring gravitational waves in the sub-Hz band using inter-spacecraft interferometry. LISA consists in a constellation of three satellites in triangle formation with 2.5 Gm-long arms following along an Earth-like heliocentric orbit. The target sensitivity of pm/Hz1/2 presents unprecedented technical challenges; such as minimal detected power levels. One of the main issues is the coupling of the angular jitter of the spacecraft and test masses to the interferometrically measured longitudinal displacement (Tilt-To-Length coupling, or TTL). In order to minimize this, the alignment of the satellite constellation is going to be a crucial factor. For this reason, LISA reads out both length and angular signals, implementing a method known as Differential-Wavefront-Sensing (DWS), that combines the individual phase readouts from the four segments of a Quadrature PhotoDiode (QPD). An ultra stable interferometer testbed representative of the Optical Bench (OB) of a LISA spacecraft has been developed in order to validate critical interferometric techniques for the LISA mission. The testbed features a pair of steering mirrors that can induce synthetic tilts between the beams to simulate spacecraft or test mass motion. This experiment has been used to demonstrate optical reduction of TTL by using imaging systems to image the point of rotation of the beams into the detector plane. Current work is focusing on developing a new method to readout the DWS signals from the QPDs and on achieving a target DWS sensitivity below 1 nrad/sqrt(Hz) in the LISA heterodyne detection band.

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