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Demonstrating Interferometric Sensors to Improve Local Control of Suspended Optics

Control noise dominates the low frequency spectrum of gravitational wave detectors. Improving sensors and hence local control will ease requirements for global control and reduce noise reinjected into the detector. Three Homodyne Quadrature Interferometers (HoQIs) were installed at the middle-mass of the beamsplitter triple suspension at AEI-Hannover's 10m prototype interferometer. HoQIs have compact baseplates designed to mount on the 'lower tablecloth' of the Big BeamSplitter Suspension (BBSS) for LIGO's A+ upgrade. Hollow, gold-coated retroreflectors mounted on the mass improve robustness to misalignment. The complete optical and electronic signal chain for in-vacuum use was tested. Signals were dominated by ground motion, but a level of ˜$3 \times 10^{-13}\mathrm{m}/\sqrt{\mathrm{Hz}}$ was seen at a few hundred Hz. The fringe visibility changed by less than 0.05 when we applied the largest possible vertical misalignment of 180um. The suspension is now ready to be tested in-vacuum. The benefits of using HoQI to damp resonance peaks in the BBSS have been modelled. We predict an improvement of factor 8 in peak suppression, and factor 60 lower RMS motion of the optic at 1Hz. If deployed on multiple suspensions, this can allow a reduction of auxiliary control bandwidths and associated noise in the 10-20Hz band.

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