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Interferometric Readout of a Monolithic Accelerometer, towards the fm/√Hz resolution

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The European Gravitational wave Observatory Virgo is undergoing an upgrade to increase its strain sensitivity to about 3e-24 1/√Hz in the detection band of 10 Hz –10 kHz. The upgrade for this detector necessitates seismically isolating sensing optics in a vacuum environment that were on an optical bench outside vacuum in previous Virgo configurations. For this purpose, Nikhef has designed and built the five compact isolators, called MultiSAS.
To measure the residual motion of the optical components and the transfer function of the isolator in full assembly, no (commercial) sensor is available that has sufficient sensitivity. A novel vibration sensor has been built at Nikhef that features an interferometric readout for a horizontal monolithic accelerometer. It will be able to measure in the vicinity of the fm/√Hz regime from 10 Hz onwards. Current results show unprecedented (self) noise levels around 30 fm/ √Hz from 20 Hz onwards, 1 order of magnitude too high.

Collaboration

The instrumentation section of our group focuses on the low frequency (<10 Hz) part of (possible) improvements to the overall sensitivity curve of the detector collaboration we are a part of: Virgo, a 3-km-arm interferometer near Pisa, Italy. Improving the low frequency sensitivity mainly entails vibration isolation of the interferometer's components and/ or subtraction of seismic motion and seismic waves, respectively.

Summary

Our reason for building this sensor and why other commercial sensors haven't been made to this precision is explained. The current configuration and how to calibrate such a sensor is next. Results and the comparison to other sensors is made. Suspect noise sources for not reaching the modelled 3 fm/√Hz is touched upon. If there's time left, a modified version interesting for particle accelerator application (strong magnetic field/ radiation environments), that we're also working on in parallel, is shown, with possibly some prelimenary results.

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