High resolution optical accelerometers for active vibration isolation

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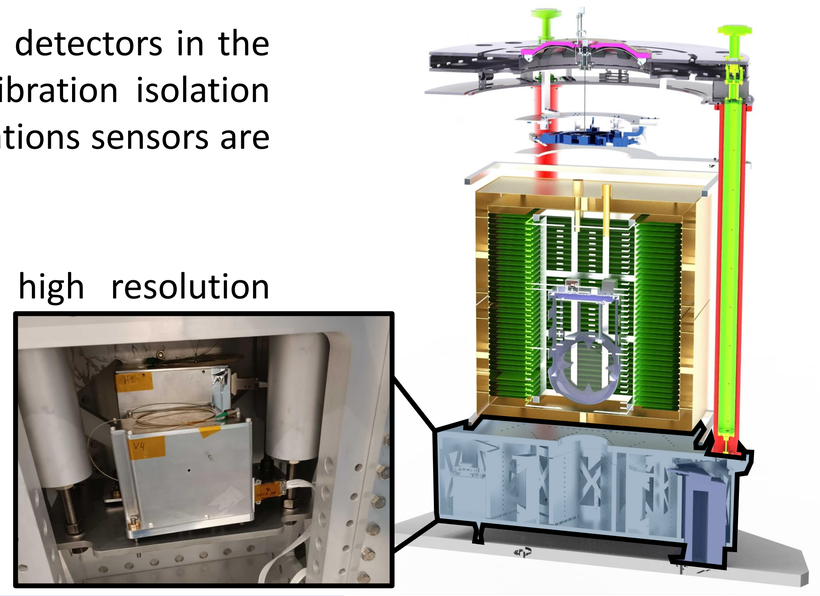
Context

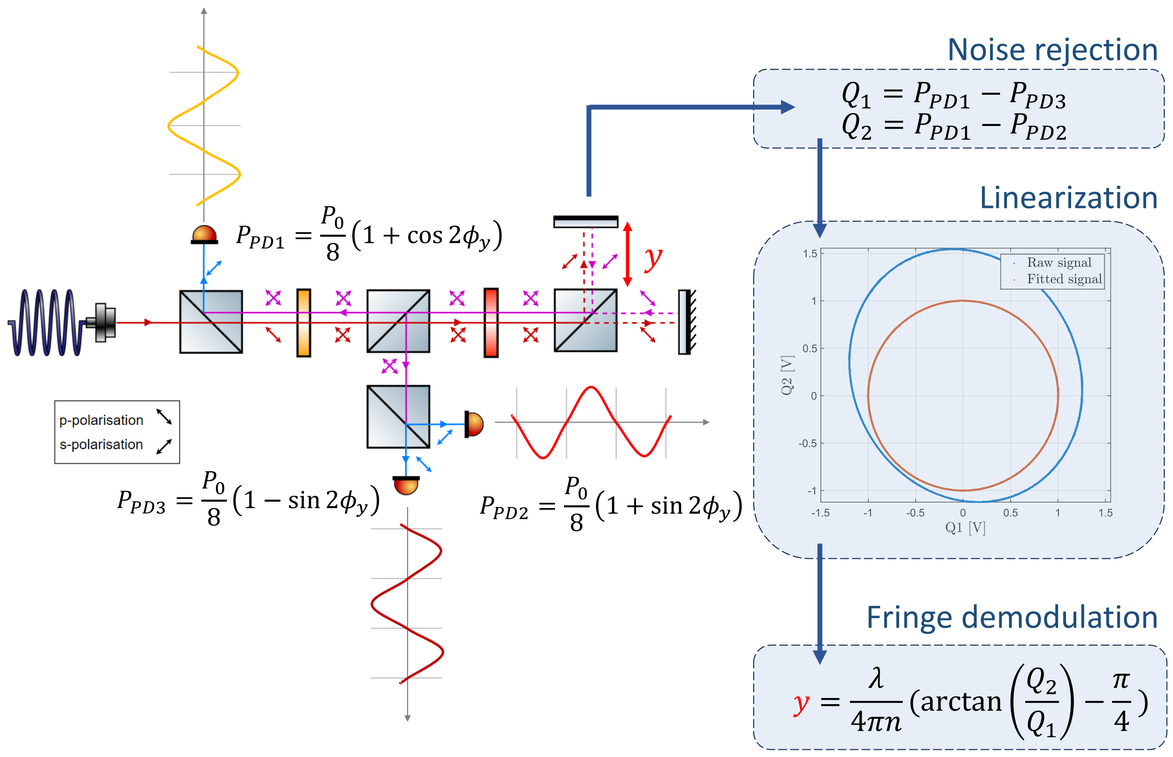
Seismic motion noise is a major limiting factor in the sensitivity of advanced gravitational wave detectors in the low frequency ranges [1]. The ETEST [2] project proposes, amongst others, a novel hybrid vibration isolation system for the Einstein Telescope. Since one can only isolate as much as what he can sense, vibrations sensors are the keystone of the active vibration system!

In the framework of this ambitious project, the PML and UCLouvain teams developed high resolution accelerometers and inertial sensors for the in-loop isolation systems. They feature:

- Sub-pm resolution using a custom homodyne quadrature Michelson interferometer [3].
- Low-frequency dynamic range using sub-Hz suspension mechanism.
- High-vacuum compatibility: all material comply with the LIGO-E960050-v11 compatibility list.



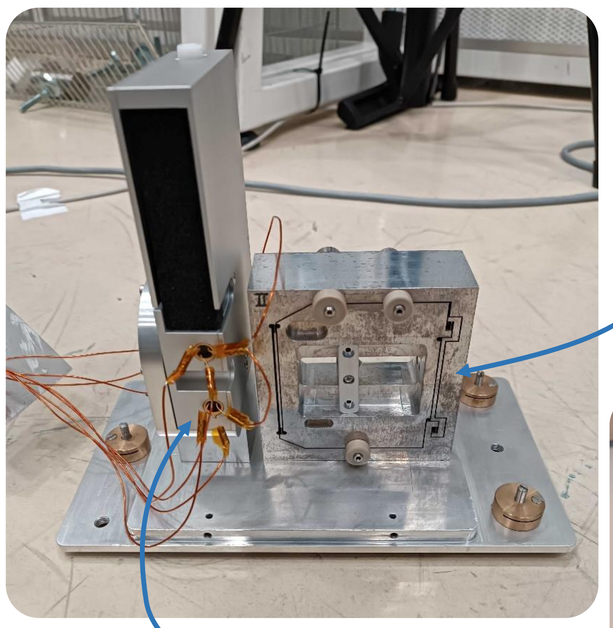
Optical readout



- Michelson interferometer-based readout featuring polarized laser beams for an extended dynamic range.
- Common-mode noise and non-linear optical effects mitigated by a real-time demodulation process [4].
- 2×10^{-13} m/√Hz resolution tested on a blocked-arm setup.

eHINS and eVINS

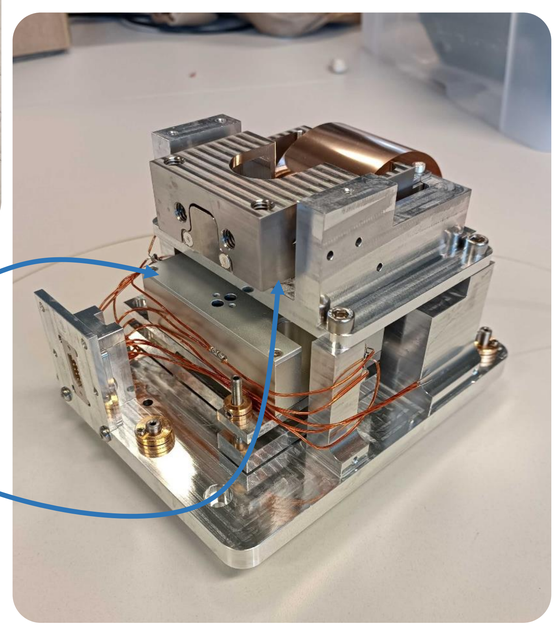
- Soft uniaxial mechanism for the suspension of the proof mass.



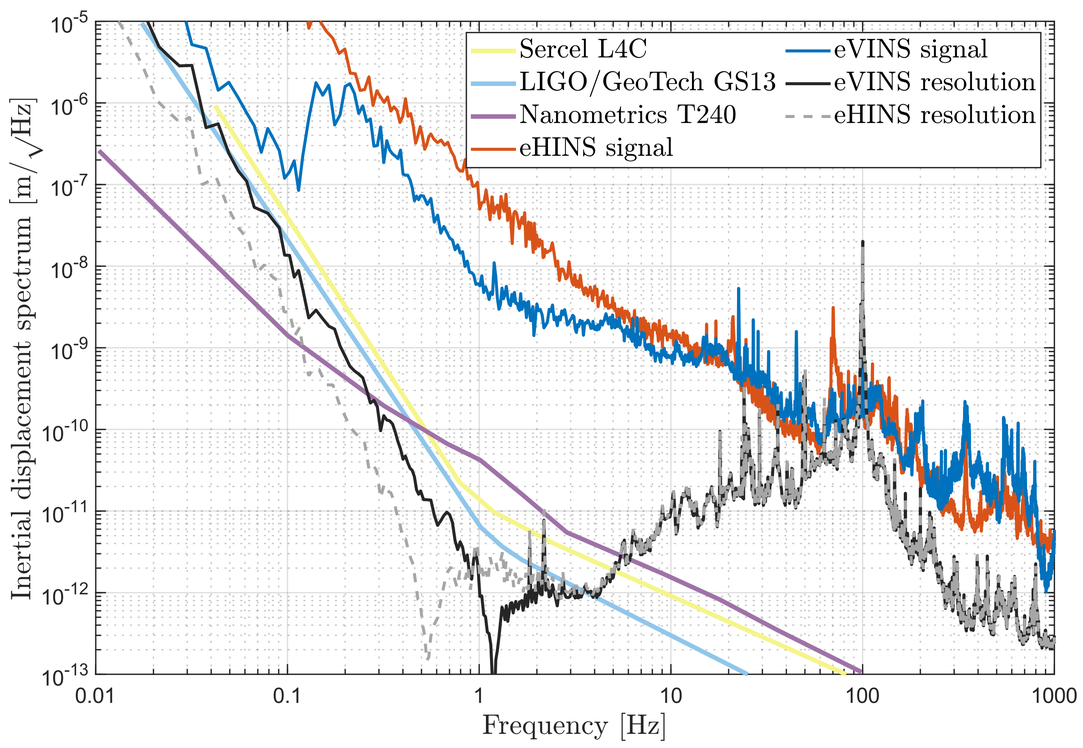
0.6 Hz resonance frequency Watt's linkage.

Optical readout.

1.1 Hz resonance frequency leafspring suspended pendulum.



Performance



References

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