Large band low frequency sensors based on Watt's linkage for future generations of interferometric detectors

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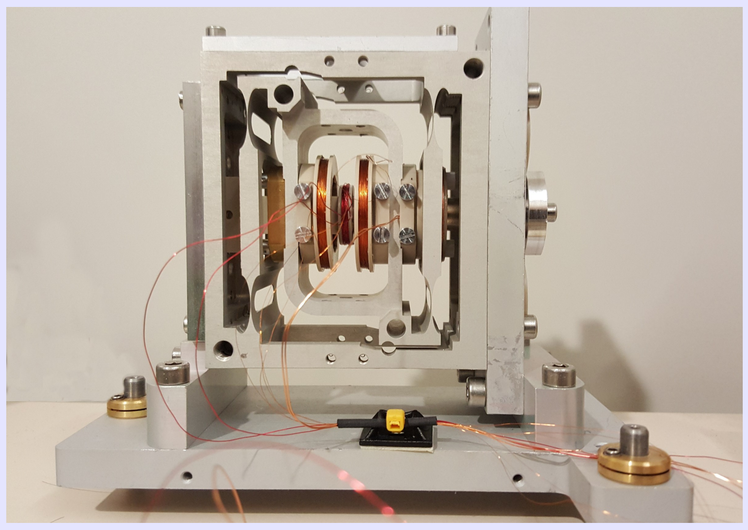
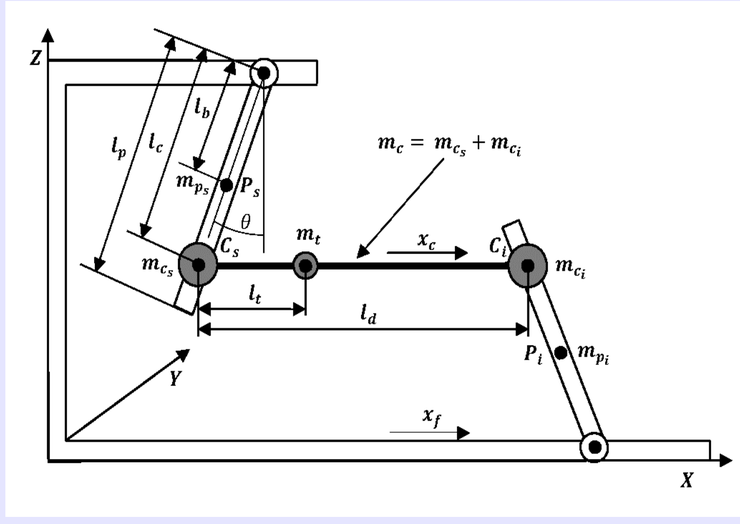
INTRODUCTION: We present a compact and light low frequency sensor based on a horizontal folded pendulum mechanical design (patented as Model UNISA GE 2015). The device can be used both as seismometer and as accelerometer and in both open and closed loop configuration. The instrument has been developed by the Applied Physics Group of the University of Salerno while the readout, control electronics and software by the INFN Pisa Group. We evaluated the sensor performance both as instrument for seismic and Newtonian noise measurement and as control sensor for mechanical suspensions.

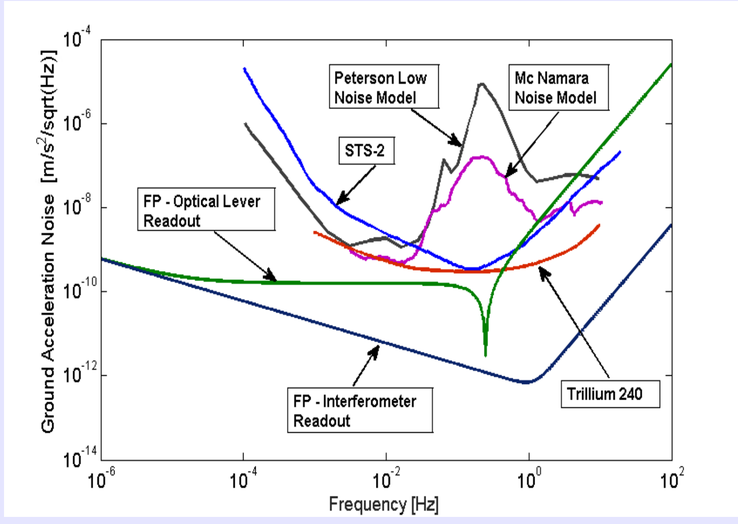
Horizontal Monolithic Folded Pendulum Model UNISA GE 2015 (patented)



Folded Pendulum Basic Mechanical Scheme

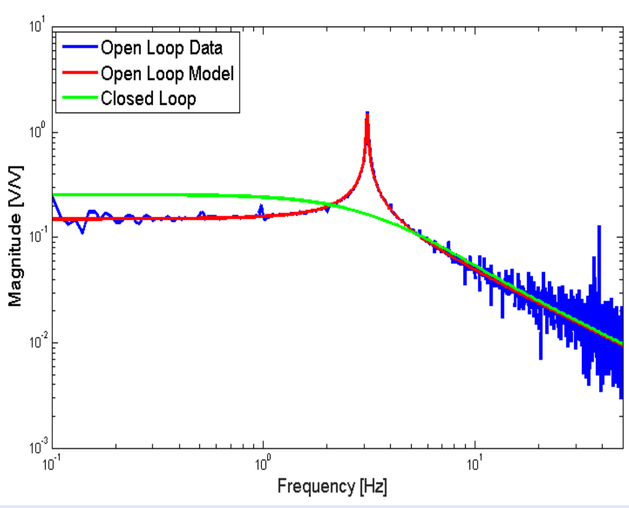


Optical Readouts Sensitivities of Folded Pendulums compared to Ground Noise and Commercial Instruments Sensitivities

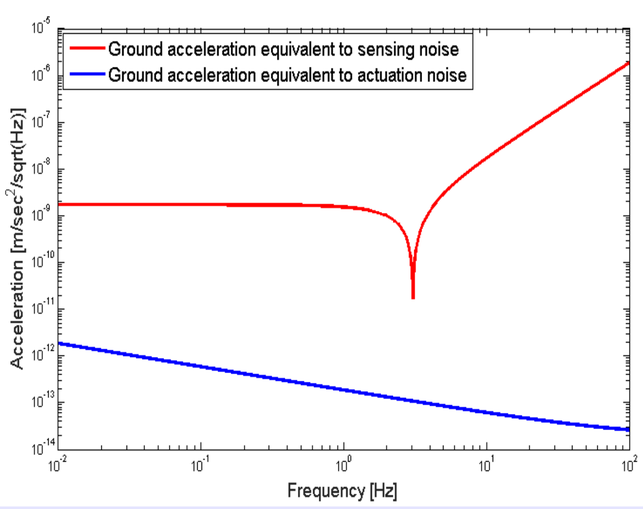


RESULTS: We show here the test results of the device configured as accelerometer. The setup consists of a Folded Pendulum Sensor equipped with an LVDT ($5 \cdot 10^{-12}$ m/sqrt(Hz) of sensitivity) and a coil-magnet actuator connected to an UDSPT INFN board for signal conditioning, conversion and processing and for the real time control of the sensing element.

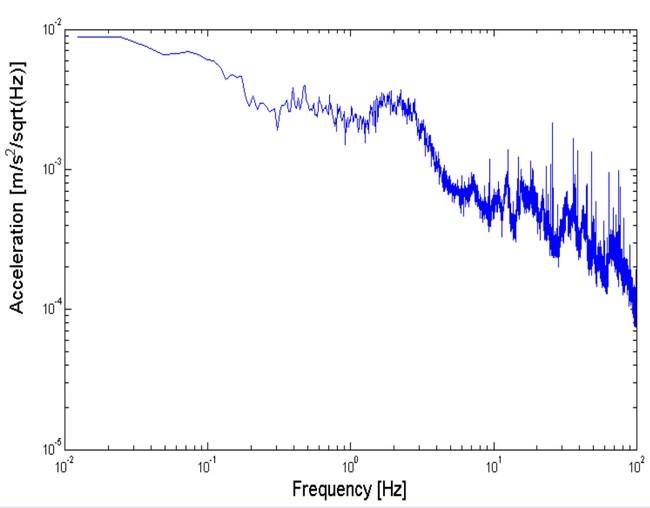
Open and Closed Loop Transfer Functions



Sensitivity and Noise Budget



Seismic Noise Measurement - Preliminary Test



CONCLUSIONS:

- The monolithic mechanical folded pendulum equipped with LVDT readout has been perfectly integrated with the new UDSPT board developed by the INFN Pisa Group for Advanced Virgo.
- The performance of the integrated sensor ($2 \cdot 10^{-9}$ m/s^2/sqrt(Hz) for f<1 Hz) already satisfies the present requirement for horizontal accelerometers of the suspension control in Advanced Virgo.
- Although not yet fully optimized (there is still a large margin of improvement), the sensor can be already considered an effective instrument both for seismic and Newtonian noise measurement and a light and reliable inertial sensor for the control system of seismic attenuators of present and future gravitational wave detectors. .

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