High resolution compact vertical inertial sensor for atomic quantum gravimeter hybridizing

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We present a conceptual design of a high resolution, compact, interferometric inertial sensor intended for hybridizing with am atomic quantum gravimeter. The mechanics of the sensor is a four bar-pendulum oscillating in a vertical plane. The mechanics is maintained in an horizontal position to prevent couplings to transverse direction by means of a low-stiffness copper-beryllium leaf spring, achieving a relatively low natural frequency of 2.8 Hz. The mechanics joints are made of 3D printed fused silica flexures, guaranteeing a low level of structural thermal noise. The motion of the proof mass is monitored using a custom homodyne, quadrature, Michelson interferometric readout, which uses laser beam propagating in phase-quadrature to allow a long-range measurement with a relative resolution of 2×10^{-13} m/$\sqrt{\text{Hz}}$ at 1 Hz. The four-bar mechanism provides the proof-mass with a angle-maintaining motion so that flat mirror can safely be used without losing alignment of the optical readout. A custom voice-coil actuator is used for freezing the motion of the pendulum, therefore ensuring that the readout remains within its linear operating range and extending the bandwidth of the device. The voice-coil actuator is made of self-shielded quadrupole magnet designed to reduce the Eddy-current damping induced by its magnetic shield. The entire design is made to be compact and fit in a $10 \times 10 \times 10$ cm^3 box. This sensor is also intended to be compatible with an UHV environment.