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Compact Four degree-of-freedom Seismometer with Capacitive Readout

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Seismic noise in both translational and angular degree-of-freedom poses significant challenges to high-precision measurements. To mitigate low-frequency seismic noise coupling, active vibration isolation platforms have been developed, with the combination of low-noise and single or multiple degree-of-freedom seismometers play a critical role. This paper presents the design and performance evaluation of a four degree-of-freedom seismometer based on an single flexure inverted pendulum within a $15\,\mathrm{cm}$ cube. The seismometer employs differential capacitive sensing scheme to readout test mass motion, similar to which used in the LISA gravitational-wave detector. Two sensing modes are employed: 2D mode and 4D mode. In 2D mode, translational motions are measured, with an optimal translational noise floor of $2 \times 10^{-10}\,\mathrm{m/s^2/\sqrt{Hz}}$ around 1 Hz. In 4D mode, a single seismometer can measure both translational and angular motion, whereas two spatially separated XYZ seismometers would typically be employed. However, the angular sensitivity is limited by the compactness of seismometer and the intrinsic stiffness of flexure, which leaves for future optimization.

Collaboration you are representing

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