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Use of a vibrating beam MEMS accelerometer for surface microgravimetry

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A vibrating beam MEMS gravimeter with an Allan deviation of 9 μGal for a 1000 s integration time, a noise floor of 10 μGal/√Hz, and measurement over the full ±1 g dynamic range (1 g = 9.81 ms^{-2}) is presented. In addition to a direct digital signal output, the sensor system possesses built-in tilt compensation capabilities and a 2-stage temperature control that is stable to 500 μK.

Instances of Earth tidal tracking and ground motion records corresponding to several teleseismic events are demonstrated. The output response from tracking of the Earth tides is compared to the data obtained from the software TSoft and a statistical correlation R of 0.92 is obtained between the conditioned MEMS dataset over a period of ~4 days and the predicted Earth tides model from TSoft following correction for ocean loading effects.

The device also recorded the ground motion from several teleseismic events during the testing period, a prominent event among them is the 6.2 M_L earthquake near to Petrinja, Croatia, which occurred on December 29th, 2020. The MEMS sensor has demonstrated excellent performance as a long-period seismometer and the response is compared to the seismograms recorded by two nearby BGS broadband seismic stations.

Advances in microgravity sensor detection capability will be shown to match feasibility modelling for void detection. Results demonstrate that a vibrating beam MEMS accelerometer can be used for measurements requiring high levels of stability and resolution with wider implications for precision measurement. Gravimetry use to warn of imminent failures due to a range of shallow hazards include assessing damage in the built environment, transmission losses in utilities, territory breach and storage containment loss.