

Performance evaluation of laser strainmeters

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We have constructed four laser strainmeters which are in operation to observe Earth's strain in underground sites in Japan. The strainmeters are asymmetric Michelson interferometers implemented with a long main arm (ranging from 100 m to 1.5 km, depending on deployment) that follows ground motion and a short reference arm (shorter than 1 m) which is mounted on a stable platform isolated from the ground. The ground strain is observed by detecting phase difference of the two beams that enter and return from these arms. Due to the sensitivity of the phase difference to laser frequency caused by the mismatch of the arm lengths, the laser frequency needs to be stabilized to maintain high resolution of the instruments in long term. For this purpose, we developed a laser frequency stabilization system that locks a Nd:YAG laser to one of the iodine absorption lines, with the designed stability of 10^{-13} to 10^{-12} . In order to evaluate the performance of the strainmeters, we have been studying stability of the lasers by comparing equivalent systems in situ. The details and results of the experiments are presented together with the estimated performance of the strainmeters.

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