



A global network for underwater earthquake detection using the existing submarine optical fibre network

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Detecting underwater earthquakes is crucial for understanding the interior of the Earth and its dynamic behaviour. However, only a limited number of permanent ocean bottom seismometers exist today because of their prohibitive installation cost. Here we show that, using state-of-the-art frequency metrology techniques, standard telecommunication optical fibre links can be used as earthquake detectors. With this technique, the optical fibre cables already installed on the sea floor could be used to implement a global network for underwater earthquake detection.

In our experiments we have detected earthquakes on terrestrial and submarine optical fibre links located in the UK, Italy and Malta and of length up to 535 km. Local and tele-seismic events were detected, with epicentre distance ranging from 25 to 18,500 km. These include earthquakes in New Zealand, Japan, Iraq and Mexico. We propagate laser light into the optical fibre and we measure the perturbations induced by the seismic waves to the received optical phase. In order to achieve the ultra-high sensitivity required to detect seismic noise we use state-of-the-art optical frequency references based on telecommunications lasers frequency locked to ultra-low expansion glass Fabry-Pérot cavities.

In contrast with existing distributed acoustic sensing techniques, which measure backscattered light in the fibre and are limited to a few tens of kilometres, our technique measures the transmitted light (rather than reflected) and can be used over thousands of kilometres. Our technique requires only a single telecommunication channel on ordinary data-carrying optical links.

Experimental results will be presented at the conference followed by discussions on using the proposed technique for the implementation of a global network for the detection of submarine earthquakes based on the existing telecommunications underwater infrastructure.

[1] "Ultrastable laser interferometry for earthquake detection with terrestrial and submarine cables", Marra G, Clivati C, Luckett R, Tampellini A, Kronjäger J, Wright L, Mura A, Levi F, Robinson S, Xuereb A, Baptie B and Calonico D., *Science*, 361, 6401 (2018)