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High resolution passive optical seismometer connected to a long fiber for onland and offshore remote applications

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In many areas with high telluric hazard (earthquakes, tsunamis, landslides etc.), our understanding of seismogenic and mechanical processes and our ability to properly asses the related hazard is still very limited by the difficulty or the impossibility to deploy arrays of high performance seismometers in areas with harsh and challenging environment (far offshore, hot/deep boreholes, mountainous regions, etc.), due to the high installations and maintaining costs, and to the risk of loss (lightning, eruptions, rock falls, power failure, etc.) or even to the absence of suitable commercial technology (high temperature).
These last few years, innovative, high-resolution, low-cost optical seismometers have been developed to provide a real-time monitoring solution for regions of interest. The application fields of these significant advances are multiple: natural areas with a high telluric hazard, geo-industries (oil and gas production, geothermy, gas or waste storage), monitoring of structures, etc.
The IPGP, the ESEO Group and their partners Geosciences Montpellier and the Laboratory of Analysis and Architecture Systems (LAAS) of Toulouse developed an on-land and offshore, high resolution, low-cost optical (laser) seismometer (french ANR LINES). Campaigns have been conducted in order to test and qualify their first prototype of 2 Hz - optical seismometers, at the Low Noise Underground Laboratory (LSBB) of Rustrel (France). This allowed a first validation of all opto-mechanical functions of the involved sensors, including the dedicated signal processing. Thus, the acceleration floor noise level of the sensor is lower than 1ng.Hź-1/2 in the 0.3-5Hz range and remains under 10ng.Hź-1/2 in the 0.15-20Hz range.
One of the current fields of investigation, co-financed by the Technology Transfer Accelerator Office (SATT) Ouest Valorisation, consists in adapting these technologies to the design of a 3 components remote underwater seismometer. In this campaign, the integration of optical components, electronics for analog signal conditioning and digital signal processing has significantly improved the sensor performances and allowed an important reduction of power consumption (by a factor of ten). This autonomous device has been deployed during the past 6 months directly on a platform in the Brest harbour, collaborating with IFREMER and the Sea Test Base of ISEN. Our optical geophones were packaged in a hyperbaric chamber, buried in the seafloor, 500 meters away from the platform and at a depth of about 10 meters.
This presentation aims to show the results and observations collected during these campaigns, and discuss about the short and long term perspectives.