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# Low-Tech State of Polarization Seismic Monitoring over Production FTTH Cable in Campi Flegrei

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Fibre-optic telecommunication networks are increasingly emerging as pervasive sensing infrastructures for geophysical and environmental monitoring. Beyond their primary role in data transmission, optical fibres are intrinsically sensitive to external perturbations: mechanical strain induced by seismic waves modifies both the optical phase and the state of polarization of the propagating light. This property enables existing fibre networks to act as large-scale distributed or integrated sensors, offering a promising complement to conventional seismic instrumentation. In highly active volcanic and seismic areas, such as Campi Flegrei, dense and continuous monitoring is particularly relevant for improving event detection, risk assessment and early response. However, established fibre-sensing techniques often rely on dedicated fibres, specialized interrogators or highly stable laser sources, which may limit scalability and increase deployment costs. For this reason, low-complexity sensing approaches that can operate over in-service telecom infrastructure are of strong interest.

In this work, we present a multi-technology fibre-sensing testbed deployed over operational and production fibre infrastructure owned by the italian operator Open Fiber in the Campi Flegrei area. The testbed combines three complementary techniques: state-of-polarization (SOP) sensing, distributed acoustic sensing based on □-OTDR, and interferometric phase sensing. As shown in figure, the SOP and phase measurements are implemented over FTTH links departing from the same point of presence and reaching street cabinets in Agnano and Posillipo, while the DAS reference is acquired over another 22 km FTTH dark fibre owned by another italian operator (Fibercop). The SOP system uses a low-tech polarization-beam-splitter-based receiver that measures the normalized difference between two orthogonal polarization components of an intensity-modulated telecom signal. This architecture avoids coherent receivers and ultrastable lasers, and it can operate by tapping only a small portion of the optical power, preserving compatibility with live data transmission.

The experimental campaign demonstrates that the low-tech SOP approach can detect local seismic events down to magnitude 1.9. Earthquakes recorded in November 2025 were analysed and compared against independent reference measurements from DAS, interferometric phase sensing when available, and INGV seismic stations. The SOP traces clearly capture seismic signatures associated with P- and S-wave arrivals, with waveform features and spectral content consistent with the established fibre-sensing techniques. In particular, consecutive M1.9 and M3.0 events were

detected by the SOP system and validated against DAS and INGV seismic-station data, while an M3.3 event was jointly observed by SOP, interferometric phase sensing, DAS and the INGV seismic network. These results show that simple SOP monitoring over in-service FTTH links can provide reliable seismic information while significantly reducing system complexity and cost, paving the way for scalable and minimally invasive seismic monitoring using existing telecom networks.