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Three-axial Fiber Bragg Grating Strain Sensor for Volcano Monitoring

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Fiber optic and FBGs sensors have attained a large diffusion in the last years as cost-effective monitoring and diagnostic devices in civil engineering. However, in spite of their potential impact, these instruments have found very limited application in geophysics. In order to study earthquakes and volcanoes, the measurement of crustal deformation is of crucial importance. Stress and strain behaviour is among the best indicators of changes in the activity of volcanoes .. Deep bore-hole dilatometers and strainmeters have been employed for volcano monitoring. These instruments are very sensitive and reliable, but are not cost-effective and their installation requires a large effort. Fiber optic based devices offer low cost, small size, wide frequency band, easier deployment and even the possibility of creating a local network with several sensors linked in an array.
We present the realization, installation and first results of a shallow-borehole (8,5 meters depth) three-axial Fiber Bragg Grating (FBG) strain sensor prototype. This sensor has been developed in the framework of the MED-SUV project and installed on Etna volcano, in the facilities of the Serra La Nave astrophysical observatory. The installation siteis about 7 Km South-West of the summit craters, at an elevation of about 1740 m. The main goal of our work is the realization of a three-axial device having a high resolution and accuracy in static and dynamic strain measurements, with special attention to the trade-off among resolution, cost and power consumption. The sensor structure and its read-out system are innovative and offer practical advantages in comparison with traditional strain meters. Here we present data collected during the first five months of operation. In particular, the very clear signals recorded in the occurrence of the Central Italy seismic event of October 30th demonstrate the performances of our device.