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# MEDUSA: a real-time multi-parameter marine monitoring research infrastructure

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MEDUSA stands for Multiparametric Elastic-beacon Devices and Underwater Sensors Acquisition system. It is a marine monitoring research infrastructure based on instrumented geodetic-buoys with cabled seafloor multi-parametric modules operating in the Gulf of Pozzuoli (Naples, Italy) within the Campi Flegrei caldera. It mainly monitors the local seismicity and the seafloor movements (bradyseisms).
MEDUSA infrastructure is the result of the close collaboration between different groups inside INGV (Istituto Nazionale di Geofisica e Vulcanologia, Italy) and is part of a marine system of infrastructures developed in the EMSO-MedIT national project aimed at structuring the Italian contribution to EMSO, one of ESFRI Research Infrastructure.
The infrastructure consists of four buoys and as many submarine cabled modules, at water depth ranging from 38 to 96 meters, equipped with geophysical and oceanographic sensors. The infrastructure has been operating since 2016 and allows the acquisition and real time transmission of the data to the INGV monitoring center in Naples, where they are integrated with those acquired by the land networks.
The implementation of this new infrastructure, which significantly enhances the previous monitoring capabilities, is based on a previous experience gained during the construction of CUMAS (Cabled Underwater Multidisciplinary Acquisition System), the first prototype of instrumented buoy operating in the Gulf of Pozzuoli since 2008. CUMAS has allowed the acquisition of new skill in the design and management of fixed marine monitoring systems in shallow waters, making possible to reach precious milestones in the field of geophysical monitoring technologies.
Each MEDUSA buoy is equipped with a standard geodetic GNSS receiver (Leica GR10 and AR10 radome antenna), a heading ($\pm 1^\circ$), pitch and roll ($\pm 0.1^\circ$) monitoring system, the power-supply monitoring device of the overall system (current, voltage and photo-voltaic panel's power), and, only for one of the buoy, a meteorological station (air pressure and temperature, wind velocity and direction), an IP web-enabled camera, and a pulsed K-band radar tide-gauge.
Each seafloor module is equipped with a Bottom Pressure Recorder (Paroscientific, 8CDP-130I), low-frequency and broad-band hydrophones, a tri-axial broad-band (120s $\div$ 25Hz) Ocean Bottom Seismometer with auto-leveling system, a tri-axial Micro Electro-Mechanical Systems accelerometer (DC $\div$ 100Hz), clock synchronization (1PPS and NMEA) with absolute GPS time reference on RS-422 interface, a compass sensor, the power-supply monitoring system (current, voltage, water detector and on-off power control), and, for only-one of this, a 3-D current-meter with water temperature sensor. Recently, a seafloor borehole precision tiltmeter (LILY, Jewell Instruments) has been installed to extend the land tiltmeter network to the Gulf of Pozzuoli.
The overall marine monitoring research infrastructure therefore acquires more than 150 channels with sampling rate varying from 60 seconds to 200 Hz. The data are stored in a relational database and the complete time series can be visualised on a data portal, where all data can be downloaded from in various formats.