From the Geosphere to the Cosmos: ASPERA Workshop

Abstract

Bioacoustics and Geophysics at NEMO

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The NEutrino Mediterranean Observatory (NEMO) project, funded by INFN and part of the KM3NeT Consortium, is an R&D activity towards the construction of the Mediterranean km3-scale high energy neutrino detector. INFN, in collaboration with INGV, has built and operated since 2005 the NEMOSN1(Submarine Network 1) Test-Site, located in the Ionian Sea at about 2100 m w.d., 25 km off the harbor of Catania, Sicily. NEMO-SN1 is a prototype of cabled multidisciplinary deep-sea observatory, and one of the operative nodes of the incoming European large-scale research infrastructure EMSO (European Multidisciplinary Seafloor Observatory). The observatory ran in real-time several sensors that produced valuable information both for HE neutrino telescopes and Earth and Sea Sciences.

NEMO-Phase 1, the main experiment carried out at the Test-Site, consisted in the operation of a prototypal module of a HE neutrino detector, whose successful operations validated innovative technologies for KM3NeT and allowed measurement of cosmic muon flux at large depth.

Passive acoustic transducers were installed onboard the NEMO- Ocean Noise Detection Experiment (OνDE) in collaboration with CIBRA-University of Pavia (Italy), to perform real-time monitoring of acoustic noise in deep-sea, as input for studies on acoustic neutrino detection. OνDE measured acoustic noise spectrum and its correlations with environmental conditions, human activities and with the presence of marine mammals in the region. Since first recordings, in fact, OνDE discovered biological sounds revealing marine mammals passing or living in the area. The detection of sperm whales was an especially exciting find. Biologists knew that whales travel through the whole Mediterranean, the recordings provided evidence for record numbers of transiting whales and for a prolonged presence of them in the waters of Eastern Sicily. New analyses were developed to detect the marine mammals' acoustic signatures, to locate and track them. This provides new data about migration, group behaviour, and seasonal activity. All these are information relevant for marine biologists and for the conservation of the species, considered endangered and poorly known in the area.

The SN1 observatory was also deployed at the Test-Site to monitor geophysical (mainly seismic activity) and oceanographic parameters. The Western Ionian Sea is a well known seismogenic–tsunamigenic area, close to the Mt. Etna volcano. The site is also crucial for the water circulation of the entire Mediterranean Sea. High-quality seismic data were acquired: both continuous low frequency noise and earthquakes were observed. Moreover, very interesting signals connected to the different phases of Mt. Etna activity, like degassing, and seismic swarms occurred during its vigorous eruptions, were recorded. Thanks to excellent signal-to-noise ratio, SN1 recorded both local, regional and teleseismic events. At the level of local seismicity, about 30% of the recorded events were not reported on seismic bulletins.

The infrastructures conceived and tested at the NEMO-SN1 Test Site has been an important step towards the construction of deep-sea observatories incorporating HE cosmic neutrinos detectors, and sensors for Earth and Sea Science. A larger-scale improved observatory will be soon installed in Capo Passero (3500 m w.d., 100 km offshore East-Sicily) a candidate site for KM3NeT.

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