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KM3NeT acoustic positioning and detection system

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In the Mediterranean Sea, new generation neutrino detectors for astrophysics and oscillations studies are under construction within the activities of the KM3NeT deep-sea research infrastructure. In the KM3NeT neutrino detectors the Cherenkov radiation induced by the secondary charged particles produced in the interaction of cosmic and atmospheric neutrinos within a large volume of sea-water is detected by an array of thousands of photomultipliers. Photomultipliers are installed in pressure-resistant glass spheres, referred to as Digital Optical Modules (DOMs), attached on vertical string-like detection units (DUs) about 700 m high, anchored on the sea-bottom. Each DU hosts 18 DOMs containing 31 photomultipliers, several calibration instruments and readout electronics.
The direction of charged particles emerging from neutrino interactions needs to be reconstructed with high precision in order to accomplish the scientific objectives of KM3NeT. To achieve this, DUs must be geo-referred with an uncertainty of about two meters and the relative positions of the DOMs must be continuously monitored with an precision better than 20 cm .
These requirements are met through a long baseline (LBL) acoustic positioning system composed of a number of transponders (emitter-receiver couple) installed at fixed positions on the sea-bottom and of an array of time-synchronized piezo-acoustic receivers installed inside DOMs. Knowing the sound velocity profile along the water column and the time of flight of the acoustic pulses emitted by the LBL transponders to reach each piezo-acoustic receiver, DOM positions are calculated through multi-lateration procedures.
Thanks to an innovative data acquisition system based on "all data to shore"philosophy, data acquired by the acoustic receivers of the KM3NeT positioning system can be also used for the detection and tracking of underwater acoustic sources (natural and anthropogenic) and to develop innovative techniques for very high energy neutrino detection founded on thermo-acoustic model.

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