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The Sound Emission Board of the KM3NeT acoustic positioning system

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We describe the sound emission control board of an acoustic positioning system necessary to triangulate flexible optical detection lines in the KM3NeT future deep sea neutrino telescope. Such a positioning system must log the positions of optical sensors for Cherenkov radiation emitted in sea water to precisions of ˜10cm, over a >1 km3 instrumented volume. This will be achieved by acoustic triangulation of sound transit time differences between fixed seabed emitters and receiving hydrophones attached to kilometer-scale vertical flexible structures carrying the optical sensors. New custom-built sound emission boards will generate the time stamped sound bursts used in this system.

Summary 500 words

The KM3NeT telescope will consist of hundreds of Detection Units (DUs) containing optical sensors able to detect Cherenkov light emitted by the muon propagation when a neutrino interacts with matter. DUs are almost 1 km-height structures anchored on the sea floor and maintained vertical by submerged buoys. Since the DUs are flexible structures they move due to sea currents however for precise track reconstruction the relative positions of the optical sensors must be known with accuracies of about 10 cm. For this, an Acoustic Positioning System (APS) is mandatory to provide useful and accurate information during the deployment and the operation phases of the telescope. The APS is formed by anchored acoustic transceivers (composed of an acoustic transducer and Sound Emission Board (SEB) electronics) and receiver hydrophones attached to the DUs. Measurement of the acoustic transit times between the emitters and the receiving hydrophones, and knowledge of the sound speed in deep sea water, allows the position of the hydrophones being monitored by triangulation.

The specs for the SEB are that it must be very reliable (operational for long time in the deep sea), small (available space is limited), versatile (emission, reception, communication and control processes). It must be able to drive with 1 μs time accuracy short high-power signals (300 W) adapted to the transducer (SX30 Free Flooded Ring from Sensor Tech. Inc., Canada) and generated from limited electrical supply power (about 1 W). Low noise is also required for reception for compatibility with the all-data-to-shore data transmission approach.

The paper will describe the solution adopted for the SEB, which handles all the aspects in an integrated board especially developed using a DSPic microcontroller (33FJ256MC710), which drives a full-bridge D-class amplifier (HIP2101 & IRLR3715ZPBF) using the DSPic internal high speed PWM generator. The high power signal generated by the amplifier is adapted using a 1:20 transformer and an impedance matching layer because the impedance of the SX30 transducer is high (130-1000j) ohm. And finally the SEB uses low ESR parallel capacitors to store the energy, and thus, be able to reach the power needed for emission.

The SEB prototype will be validated this year in deep sea in different KM3NeT R&D tests in ANTARES and NEMO sites

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