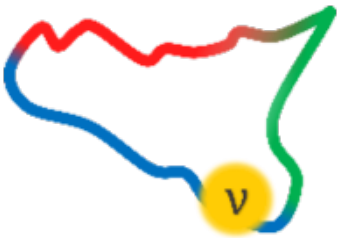

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In-situ Time Calibration of KM3NeT ARCA

KM3NeT (Kilometre Cube Neutrino Telescope) is the largest underwater observatory worldwide. It is composed of two detectors deployed in two sites of the Mediterranean Sea (ARCA in the Ionian Sea and ORCA in the Ligurian Sea), and it is designed to detect high-energy (> 100 GeV) neutrinos through the Cherenkov radiation. The reconstruction of the neutrino direction relies on the detection of Cherenkov photons emitted by secondary charged particles, and achieving high angular resolution requires nanosecond-level time synchronization between photomultipliers. To meet this goal, the KM3NeT ARCA detector has recently implemented a full White Rabbit (WR)-based system for time synchronization, reaching a ns accuracy in time distribution across the detector components. This work presents the description of implementation of this timing architecture, detailing the on-shore calibration procedures of the White Rabbit system. System performance is further evaluated through an in-situ validation using the laser beacon, a powerful light source deployed on the seafloor that enables independent checks of the timing calibration.. Additionally, the work discusses a new calibration system within the KM3NeT Collaboration to intercalibrate darkrooms, ensuring a common timing reference across all production sites, thus enhancing the consistency and reliability of the detector.

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