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The data acquisition system for Phase-2 of the KM3NeT/ARCA neutrino telescope

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The KM3NeT observatory hosts two undersea neutrino telescopes, ARCA and ORCA, located at two abyssal sites of the Mediterranean sea. The detectors consist of a 3D array of optical modules, each housing 31 3-inch photomultiplier tubes to detect Cherenkov light emitted by charged particles produced in neutrino interactions in water. Although still under construction, both detectors are already using the same data acquisition model in compliance with the triggerless-streaming readout approach. In this architecture all the data collected by optical modules are transmitted to shore, where online processes running on dedicated resources filter and record relevant data for physics analyses and calibration procedures. To accomplish the target scientific goals, stringent constraints on the precision of the position and timing of the modules are set. In particular the clock distribution must provide a nanosecond synchronisation of the modules which are tens of kilometers away from the on-shore clock references and occupy large volumes that, in the case of ARCA, can reach the cubic kilometer scale. This requirement is met by exploiting the White Rabbit technology.
ORCA telescope and Phase-1 of the ARCA telescope, which accounts for 13% of the total instrumented detector, are based on a custom White Rabbit implementation that deviates significantly from the standard design. Recently the connection layout of the ARCA telescope was significantly revised to accomplish a mandatory optimisation necessary to scale it to the cubic kilometer size. In this new scenario, which is referred to as the Phase 2 of ARCA construction, it was possible to revise also the implementation of the White Rabbit technology, restoring the original standard design.

In this contribution the evolution of the ARCA data acquisition system from Phase 1 to Phase 2 is reviewed, focusing on the revised White Rabbit-based architecture, its role in both data transmission and time synchronization, its implementation with the new detector components that were recently deployed and are operational since the fall of 2024, and the integration of Phase-1 and Phase-2 sectors.

Neutrino Properties

Not relevant track

Neutrino Telescopes & Multi-messenger

Less relevant track

Neutrino Theory & Cosmology

Not relevant track

Data Science and Detector R&D

Most relevant track

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