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The Digital Optical Module of the KM3NeT project

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The KM3NeT project is building a neutrino telescope in the depths of the Mediterranean Sea. The telescope will consist of cubic kilometer sized 3-dimensional arrays of Digital Optical Modules (DOMs), suspended in the sea by vertical string structures, called detection units.

The KM3NeT telescope will comprise two detectors with different density of the optical modules: KM3NeT/ARCA at the KM3NeT-Italy site dedicated to high-energy neutrino astronomy and KM3NeT/ORCA, a denser detector located at the KM3NeT-France site and dedicated to the study of neutrino mass hierarchy.

The optical modules, which represent the sensitive part of the neutrino telescope, are pressure-resistant 17-inch diameter transparent glass vessels, each hosting 31 3-inch diameter photomultiplier tubes and all the ancillary sensors and associated electronics for synchronization, front-end and signal read-out.

The multi-PMT solution represents an innovative design, considering that the optical modules of all the other neutrino telescopes –ANTARES, Baikal and IceCube - have a design with a single large photomultiplier, typically with a photocathode diameter of 10 inch. This novel solution, in which the signals of the individual photomultipliers compose a segmented photodetector, allows for accurate photon counting and offers directional information and the capability of background rejection at the DOM detection level. The use of many small-area photomultipliers increases the total detection area of the optical module compared to a design with a single 10-inch photomultiplier, also taking advantages from the weaker sensitivity to the Earth's magnetic field and the better timing characteristics.

The design has been already demonstrated in-situ by several prototypes. Since end 2015, two full size detection units are operational at a depth of 3500 m, installed in the KM3NeT-Italian site. In this contribution the innovative design of the KM3NeT Digital Optical Modules is discussed, with a particular focus on the main components and the enabling technologies.

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