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Brand-new optical modules for the KM3NeT neutrino detector

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The discovery of cosmic neutrinos by IceCube in 2013 gave to the field of high-energy neutrino astronomy a new exciting momentum. IceCube and ANTARES detectors, respectively in the ice of the South Pole and in the French deep-water of the Mediterranean Sea, are providing high-quality data and have become an important component of multi-messenger astronomy. New cubic kilometer size detectors are already under construction: KM3NeT in two deep-sea sites of the Mediterranean Sea, in France and Italy, and Baikal-GVD in the Lake Baikal of Russia.
All the different detectors can be generically described as a grid of optical sensors, called optical modules, which are sensitive to the Cherenkov radiation emitted by charged particles produced by neutrino interactions.
Despite the same scientific objects, all the projects adopted different layout and technical solutions for the optical module design. IceCube, ANTARES and Baikal used a single large area photomultiplier, typically with a photocathode diameter of 10 inch, housed into 13 inch or 17 inch diameter transparent glass vessels.
The KM3NeT project already started a mass production of optical modules with an innovative multi-PMT design with 31 3-inch photomultipliers integrated into a 17-inch glass sphere.
This novel solution has several advantages with respect to optical modules that comprise single large photomultipliers. Since each PMT works independently, the segmented photocathode layout offers photon counting with high efficiency and provides directional information and rejection of optical background just at the DOM detection level. Moreover, it reaches almost three times the photocathode area of a single glass sphere equipped with a 10 inch PMT and has an almost uniform angular coverage.
The proposed contribution aims to give a general overview about the different optical module designs, with a particular focus on the main characteristics of the multi-PMT novel solution of the KM3NeT project.

Primary author: LEONORA, Emanuele (CT)

Presenter: LEONORA, Emanuele (CT)

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