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Improving the KM3NeT sensitivity

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KM3NeT is a future European research infrastructure that will host a neutrino telescope with an instrumented volume of at least one cubic kilometre, located at the bottom of the Mediterranean Sea at a depth of several kilometres. Detection of high-energy neutrinos from distant astrophysical sources or from annihilation of dark matter particles will open a new window on the Universe. The detection principle exploits the measurement of Cherenkov light emitted by charged particles resulting from neutrino interactions in the matter surrounding the telescope. The innovative KM3NeT detection units will be instrumented with multi-PMT optical modules (OM) containing 31 3-inch phototubes. The segmentation of the detection area in the OM will aid in distinguishing single-photon from multi-photon hits. Moreover, two-photon hits can be unambiguously recognized if the two photons hit separate tubes, which occurs with 85% probability for photons arriving from a particular direction. Small phototubes can offer a quantum efficiency above 30%, provide a small transit time spread and are do not require shielding from the Earth's magnetic field.

Three companies ET Enterprises, Hamamatsu and MELZ-FEU develop new types of 3-inch PMTs for the KM3NeT project. First PMT samples have been delivered from the companies and tested. These results are presented.

In order to maximize the detector sensitivity, each phototube in the multi-PMT OM will be surrounded by a reflector cone designed to collect photons that would normally miss the photocathode, thus effectively increasing the effective photocathode area. Measurements will be presented that indicate an increase of the effective photocathode radius by about 8 mm. Light propagation studies have shown that an increase in the overall sensitivity by 25% is possible.

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