



ERASMUS MUNDUS JOINT MASTER IN NUCLEAR PHYSICS

Academic Year 2026/2027

MASTER THESIS PROPOSAL

TITLE: Study of the optical properties of a Cherenkov telescope in seawater using muons.

SUPERVISOR(S): Valentin PESTEL, Gregory Lehaut

SUPERVISOR(S) contact- email: vpestel@lpccaen.in2p3.fr Telephone: 02.31.45.29.83
email: lehaut@lpccaen.in2p3.fr Telephone: 02.31.45.29.89

UNIVERSITY/RESEARCH CENTER: LPC Caen

ABSTRACT

(just few lines 5-10 explaining briefly the idea of the proposed work and the place where it will be developed).

KM3NeT is an international collaboration currently deploying and operating two large neutrino telescopes at the bottom of the Mediterranean Sea. Both rely on the same detection principle: charged particles produced in neutrino interactions emit Cherenkov light as they travel through water. The deep sea provides an ideal environment for this detection, offering a vast volume of water in complete darkness, with several kilometers of water above acting as a shield against background particles. The trajectories of these particles are accurately reconstructed using a network of photo-sensors that time-sample the light emission in 3D.

Water optical properties, such as the absorption and scattering lengths, introduce systematic uncertainties in the energy estimation, which is one of the dominant sources of systematic error in the neutrino mass ordering measurement.

Muons are a free source of events for our telescope: they emit light as they travel through it via different processes, thanks to their broad energy spectrum. While high-energy muons lose energy through stochastic interactions, low-energy muons are mainly in the minimum-ionizing regime, where the energy loss is approximately constant.

During this internship, we propose to validate a detector-agnostic selection of stopping muons (i.e., a selection of low-energy muons that can be used for different detector sizes). After the selection, a statistical comparison of the light yield between data and simulation will place constraints on the absorption and scattering lengths.

The required skills for this internship are knowledge of particle interactions with matter, statistical analysis, and programming in Python.