Thesis proposal 2018

TITLE: "Study of the response of the dual-phase liquid argon TPC, WA105 at CERN, and the application of the developed tools and results on the detector performance to the DUNE experiment at Fermilab for long-baseline neutrino physics and neutrino astrophysics''

RESEARCH THEMES: Neutrino oscillations, mass hierarchy, leptonic CP violation, nucleon decay, solar, atmospheric and supernova neutrinos

RESEARCH GROUP in the Laboratory: APC-Neutrino

SUBJECT AND NATURE OF PROPOSED WORK: Physics potential of the next generation neutrino observatory. The thesis will cover MC simulations and data analysis based on modern computing approaches like machine-learning as well as R&D work for the future detector.

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Scientific Motivation and Work Proposal:

After the 2015 Nobel Prize for Physics awarded for the discovery of neutrino oscillations, some questions on the properties of neutrinos remain unanswered: which neutrino is the heaviest? Is there CP violation in the leptonic sector? What is the exact value of the oscillation parameters?

These questions will be addressed by the DUNE (Deep Underground Neutrino Experiment, www.dunescience.org) project, envisaging the construction of a very large detector (4x10 ktons), based on the technology of the liquid-Argon TPC, to measure the oscillations of neutrinos from a beam produced by the Fermilab accelerators, at a distance of 1300 km. The experiment will also perform precision measurements on atmospheric neutrinos and address fundamental questions of particle physics, such as the stability of the proton.

As a first step towards this new large-scale detector, CERN has accepted to provide the infrastructure and a considerable participation to a 6x6x6 m^3 prototype of a dual-phase liquid argon TPC in a charged particle beam (CERN experiment WA105). The dual-phase for the ionization charge readout is expected to provide superior capabilities for the reconstruction and measurement of particle interactions. The aim of WA105 is to demonstrate the detector response to charged particles and the technical feasibility of the detector.

The French participation to the project is funded by IN2P3. The contribution of the APC

Laboratory team focuses on the system for readout of the scintillation light.

The student will perform realistic simulations and develop analysis algorithms to study the detector sensitivity. She/He will actively participate in the detector R&D related to WA105, particularly on light sensors and electronics, and will be in charge of simulating the impact on the detector's physics performance. He/She should play a leading role in the analysis of the response of the dual-phase liquid argon TPC to a test beam of different particles and energies, to assess the capabilities in terms of energy resolution and particle identification. The return of the performance of the prototype will be integrated in the updated simulation of the physics performance of the large-scale detector foreseen in the DUNE experiment at Fermilab.

The result of the WA105 analysis will be a reference for future large-scale liquid argon detectors, due to the unique feature of the exposure to a test beam with known particle identification and energy calibration in the range of 0.3 GeV to 10 GeV.