Optimisation of the hadronic collector for the ESSνSB+ neutrino superbeam.

During these last decades, particle physics made lots of progresses in particular in neutrino physics with the discovery of the oscillation mechanism and bring the proof that these particles are massives which is not foreseen by the current theory. This result opens a window to new physics beyond the Standart Model. Since 2012, most ot the parameters of the PMNS oscillation mixing matrix have been estimated with a certain accuracy, but the CP violation in the leptonic sector remains unknown. This measurement could have an important cosmological implications due to their large abundance in the Universe. In order to go beyond our current knowledge and taking into account the very low interaction cross section with matter, very intense neutrino beams and large detector are necessary.

Our research group in collaboration with other European institutes proposes to design the ESSνSB+ superbeam using the European Spallation Source (ESS) based in Lund (Sweden). The objectives of this project will be to measure the neutrino-nucleus cross-section in the energy range of 0.2 to 0.6 GeV and to study sterile neutrinos which are complementary thematics to the ESSνSB project. Additional facilities are required such a Low Energy nuSTORM (LEnuSTORM) and a Low Energy Monitored Beam (LEMNB) to perform these measurements. In this project, a pulsed proton beam with 1.25 MW power will be extracted from the linac and transferred into an accumulator whose purpose will be to reduce the pulse time width of the proton pulse from 2.86 ms to 1.32 µs. The beam impinging onto a fixed target will produce essentially pion particles which will be focused by a magnetic horn system and deviated by a magnetic device placed at the end of the target station facility inside a long decay ring. These particles will decay into muons and then will produce the neutrinos. The emerging neutrino beam will point toward a Water Cherenkov near detector located few 100 m from the source.

The focusing system is a key element which strongly influence the intensity, the energy and the physics performances of the experiment. In order to optimise the parameters of this system, all the processes have to be simulated from the particle production in target, the propagation and the neutrino interactions inside the detector and extract the evaluate the physics performances. The goal of the master internship will be to optimise the hadronic collector taking into account of the current configuration of the horn system with a Monte Carlo simulation based on GEANT4/FLUKA.

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