Thesis abstract Yegor Vereshchaka

« Characterization of the timing properties of the calorimeter of the SuperNEMO demonstrator & Measurement of the 222Rn activity inside the tracker »

The neutrino, due to its low interaction probability, is a particle difficult to detect and to study. The observation of neutrino oscillations has shown that the neutrino is a massive particle and that the flavour eigenstates, related to interaction, don't coïncide with the mass eigenstates, related to propagation. The oscillations parameters have been measured. The CP violation phase and the ordering of the neutrino masses remain to be determined.

Another unknown is the nature of the neutrino particle. As a non-charged particle, it can be identical to its antiparticle, i.e. a Majorana particle. The Majorana mass term is naturally introduced by extension of the Standard Model. It could also explain the smallness of the neutrino mass and the asymmetry between matter and antimatter currently observed, through leptogenesis.

The experimental signal to prove the Majorana nature of the neutrino is the neutrinoless double-beta decay ($0\nu\beta\beta$), which is a process of two simultaneous beta-decays occurring in the nucleus resulting into two electrons being emitted without electron anti-neutrinos. This process is hypothetical and has not been observed yet. Neutrinoless double-beta decay is beyond Standard Model as the lepton number is violated in this process. In order to observe the neutrinoless double-beta decay, the Super NEMO experiment was designed with a demonstrator module to show the capability to reach an extremely low background. Among backgrounds, the ^{222}Rn is a gaseous isotope which can contaminate the detector materials and its daughter isotope ^{214}Bi can contribute to the double-beta background. The demonstrator is located in the underground laboratory in Modane (LSM) and has shieldings. In order to reduce the background coming from the detector, the radiopure materials were used, a Radon trap for the tracker gas was installed, the detector was surrounded by an anti-Radon tent, etc.

It is crucial to have the fine-calibrated calorimeter in order to search for the neutrinoless double-beta decay. Part of the work presented in this thesis is dedicated to the optical modules' fine calibration using the crossing electron events. This method allows one to determine the time shifts between the two calorimeter optical modules. Then the measurement of the time resolution of the calorimeter for electrons at 1 MeV is performed. The method uses the two electrons coming from the ^{207}Bi calibration sources to determine the time resolution, which was found to be 220 +/- 20 ps for 1 MeV-electrons.

Part of the work is dedicated to estimation of the ^{222}Rn activity level inside the SuperNEMO demonstrator. The measurement of the Radon contamination of the tracker has been performed, using the electron alpha channel. For the runs taken after the shielding installation, the signal over background is very high, larger than 100. Before the commissioning of air deradonisation in the antiRadon tent, the Radon activity is in the order of [40-80] mBq/m^3.