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[P14] Development of counter telescopes for light charged particles emitted from muon nuclear reaction on Si

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Soft errors caused by cosmic-ray have been recognized as a possible major threat to the operation of advanced semiconductor devices on the ground level. The soft error is caused by an upset of memory information induced by the energy deposition in semiconductor devices by energetic ionizing radiation. Recently, the soft errors induced by cosmic-ray muon have received much attention because of the reduction of soft error tolerance on random access memories. Our previous work clarified that probabilities of occurrence of single event upsets (SEUs) of negative muons which stopped in the device chips are 2 to 4 times higher than positive muons one [1]. It is because of the emission of light ions after the muon capture reaction on Si nuclei. In particular, it is considered that the hydrogen isotopes and alpha particles have effects on soft errors because they have higher linear energy transfer than the negative muon itself. However, there are no experimental data of energy spectra of the low-energy hydrogen isotopes and alpha particles emitted after the muon capture reaction on Si. Therefore, there is uncertainty in the estimation of the muon-induced soft error rate. To overcome this situation, we plan an experiment (μNC exp) to measure the energy spectra of the low energy hydrogen isotopes and alpha particles after the muon capture reaction on Si. To detect and measure the energy of these light charged particles, we are developing two types counter telescopes. The first telescope aims to detect high energy charged particles, and consists of an n-type Si (dE) detector and a CsI (E) detector for the dE-E technique. The second telescope aims to detect low energy charged particles that would stop in the dE detector. This telescope is composed of a neutron Transmutation Doped (nTD) Si detector and an n-type Si detector which is used as a veto detector. The nTD-Si detectors are suitable for particle identification (PID) using Pulse Shape Analysis (PSA) technique. To obtain enough experimental statistics, the nTD-Si detector has to be close to a Si target in the μNC exp. This will result in wider incident angle of charged particles to the nTD-Si detectors. To make sure the PID performance using PSA under this situation, we performed a preliminary experiment at Center for Accelerator and Beam Applied Science of Kyushu University. In this presentation, the detail of the preliminary experiment, results and the status of preparations for the μNC exp will be discussed.

[1] S. Manabe et al., IEEE Trans. on Nucl. Sci., vol. 65, 8, pp.1742 –1749, 8, 2018.

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