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Design of Radiation Tolerant Electronics for StrECal System in COMET Experiment

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The COMET experiment at J-PARC aims to search for the charged lepton flavor violating process of neutrinoless muon to electron (mu-e) conversion with an improvement of a sensitivity by a factor of 10000 to the current limit. When the mu-e conversion occurs, almost all the energy of the muon mass is carried out by the electron which is expected to have the monochromatic energy of about 105 MeV. In order to achieve the goal sensitivity, we plan to use a StrECal system as an electron detector, which consists of straw tube tracker (Str) with an excellent momentum resolution and electron calorimeter (ECal) which is used for trigger generation, particle identification and so on. To read out the signals from StrECal system precisely, optimal front-end electronics are needed. We have developed the readout electronics boards for Str and ECal called ROESTI and EROS, respectively. These boards have the same components except for the front-end part. Fundamental performance evaluation of ROESTI and EROS was almost done using the prototype boards and it was already found that the performance satisfied the physics requirements. However, those had not satisfied the requirements of radiation tolerance.
According to the simulation study, neutron fluence of ~10^{12} n/cm^2 and gamma-ray absorbed dose of ~1 kGy with the safety factor of 5 are expected at the places where the boards are located. Radiation tolerant parts has to be selected and countermeasure against single event upset (SEU) in FPGA has to be considered. Thus, we had parts selection with many times of neutron and gamma-ray irradiation tests. In the results, we found the candidates which satisfied our requirements. Development of new FPGA firmware with the function of SEU detection and correction was also done and its test was done with neutron irradiation. In the result, it was found that the function was powerful for the SEU and it satisfied our requirements. Based on those results, we have designed and developed final version of ROESTI and EROS. The performance evaluation of those is ongoing.
In this presentation, we describe the details of irradiation tests and those results. The details of the design and performance evaluation of the boards based on the irradiation tests are also reported.

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