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Development of the detector system for β -decay spectroscopy at the KEK isotope separation system

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The KEK Isotope Separation System (KISS) has been developed to study the β -decay properties of the neutron-rich nuclei around neutron number $N = 126$ which are essential for understanding how the heavy, noble-metal elements, such as gold and platinum, are formed in the r-process. It is desirable that the detector system for β -decay spectroscopy at the KISS should be highly efficient for low-energy β -rays because the nuclei of interest have Q -values of around 2 MeV. In addition, the system should be operated under a low-background environment because of the low production rates of these nuclei. Though the tolerable count rate of the background depends on the production rates, our ultimate goal is set around several 10 counts per day, allowing access to the waiting point nuclei, progenitor of gold and platinum in the r-process.

The detector system of the KISS consists of β -ray telescopes, Ge detectors, and a tape transport system. For efficiently counting low-energy β -rays with low background, the β -ray telescopes are composed of three double-layered thin plastic scintillators which act as ΔE - ΔE counters; the thickness of the first ΔE counters is 0.5 mm and that of the second ΔE counters is 1 mm. The solid angle subtended by the β -ray telescopes is, in total, as large as 90% of 4π .

In order to reduce the background events which was considered to originate from cosmic rays and environmental γ radiations, we installed a veto counter system and shields with low-activity lead blocks. The veto counter system, consisting of seventeen bar-shaped plastic scintillators surrounding the β -ray telescopes, was constructed to reduce the cosmic rays. The configurations of scintillators was designed based on the Geant4 simulation, and a designed value of the veto efficiency was 92% for 1 GeV muon.

For further reduction of the background, we have started to make a new first ΔE counter for the β -ray telescopes. In this presentation, we will introduce the present status of the detector system of the KISS.

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