Developments of a High-speed Target Transfer System for the Short-lived Nuclei

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Precise measurements for the *ft* value of $0^+ \rightarrow 0^+$ superallowed Fermi beta decays are effective tools for testing the electro weak standard model. This value has been determined in good precision less than 1% at the region of lighter nuclei (e.g. ^{10}C, ^{38m}K, ^{50}Mn, ^{54}Co)[1]. The *ft* value provides the vector coupling constant G_V, which is linked to V_{ud} up-down element of the Cabbibo-Kobayashi-Maskawa (CKM) matrix[2,3]. In combination with V_{us} and V_{ub}, V_{ud} gives the check of the unitarity of CKM matrix. However, in the $A \geq 62$ region, only few measurements were exist, ie. Chiba *et. al.*[4], because of the experimental difficulties, the small cross section and short half-lives. In this region, the precise measurements of *ft* values are desired in order to evaluate the radiative corrections for nuclear parts at the beta decay, ie. the isospin symmetry braking correction. Recently, the *ft* value of ^{74}Rb was measured at ISOLDE[5] and TRIUMF[6]. But it is not enough data to discuss these corrections at the measurements of precise Q-beta values and precise branching ratios including the non-analog 0^+-0^+ transitions[7,8].

The ISOL (Isotope Separator On-Line) is one of the most elaborate technique to select an isotope with a high purity, but this technique does not suit the measurement which needs high statistics because of low efficiency. The target transport methods with high efficiency has been utilized as one of the complementary ways. In the past work at CYRIC target rotation system[9] was used to measure the half life of ^{57}Cu, but the target rotation time was not short enough in comparison with the half life of the target nucleus. In order to achieve high statistics a new target transfer system faster than TARO. In the present system, a target mounted on cart has been linearly transported to a detector position at low background area, which is 37cm from beam position. Fig. 1. shows a new system.

The design goal is set for 50msec transfer time, which is shorter than the half-life of ^{74}Rb.

In this system, a necessary torque is 7.1N·m. To satisfy this condition, Mitsubishi HC-KFS73 servomotor (750W), which has a performance of 2.4N·m effective torque, 7.2N·m maximum instantaneous torque and effective speed 3000rpm is chosen. The target cart is moved in the vacuum chamber, and the 0.2mm thickness milar window is placed at the detector position. The operation is totally controlled by computer using YOKOGAWA FA-03 PLC modules. The position resolution for step and move is less than 3mm by 3-bit laser sensor. The time-sequence of measurement (i) An irradiation during for about 3 half-lives of a target nuclei by the cyclotron beam. (ii) The beam is switched off and irradiated target is transported to detector position about 50msec. (iii) The radiation measurement during about 10 half-lives. (iv) The target is back to the beam position with a lower speed.

The test experiment using this new system has been done for the beta decay of ^{62}Ga produced ^{64}Ga(p,3n) reaction. A 19.5mg/cm^2-thick natural zinc target is bombarded by 110nA, 45MeV protons from 930 Cyclotron at CYRIC. After beam irradiation, the target was transported to detector position by 51msec. The irradiation time was 400msec and measurement time was 1200msec. The emitted beta particles have been detected by a counter-tellescope which consisted of 2mm-thick NE102A and 5cm-thick BC408 plastic scintillators. For gamma rays measurement, HP-Ge detector was placed opposite sides of the beta counters (Fig. 2). The measured half-life is 110.1□17.6msec and is consistent with old data[10,11].

Measurements for heavier nuclei having 0^+-0^+ superallowed Fermi decays ^{70}Br and soon ^{66}As are progressing on.

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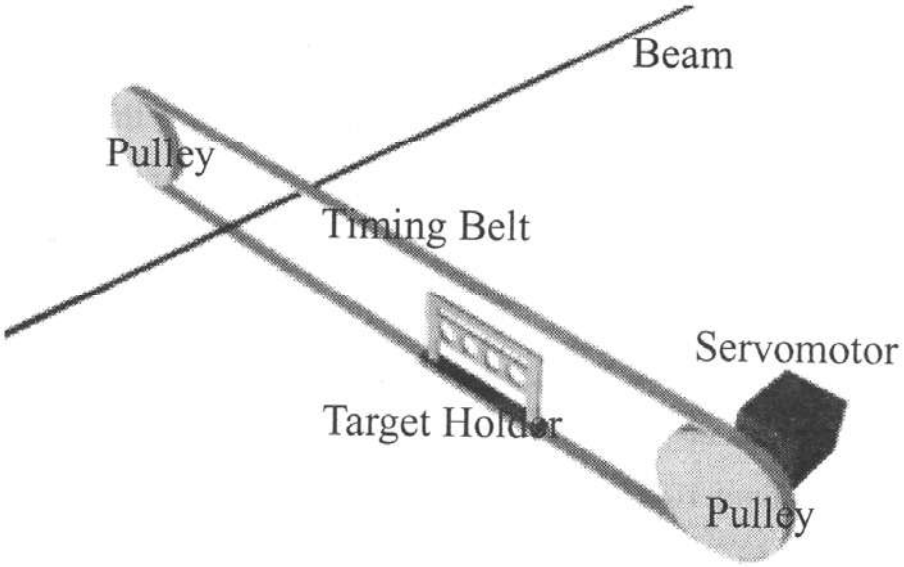

Fig. 1. The schematic of new target transfer system.

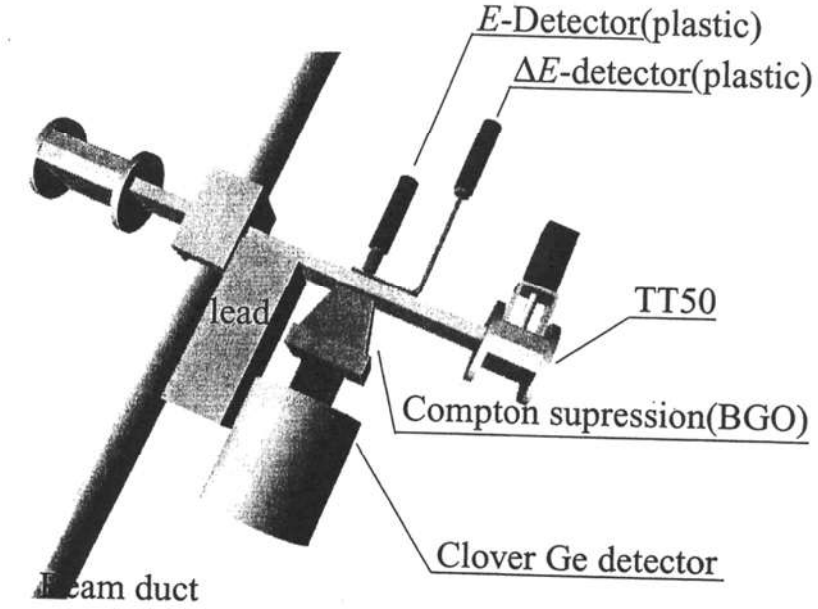

Fig. 2. Experimental setup.