

I. 16. Fabrication of a New IGISOL Chamber for Fission Product

Kudo H., Maruyama M., Hashimoto T., Shinozuka T., Sunaoshi H.*,
Fukashiro Y.*, Furukawa M.*, and Fujioka M.**

*Faculty of Science, Niigata University
Cyclotron and Radioisotope Center, Tohoku University**

The standard type of the IGISOL has been used in spectroscopic studies of short-lived nuclei. We have been using the IGISOL in the study of nuclear fission. For effective stopping of fission fragments, the large volume and the high pressure of the target chamber are required. The standard design has a small effective volume because of the short lifetime of thermalized ions against recombination with electrons produced by the projectile beam in the stopping chamber. The high energy and the nearly isotropic angular distribution of fission fragments make it possible to separate the irradiated region and the thermalizing region by a thin metal foil. By this arrangement the number of ion pairs produced in the thermalizing region will be greatly reduced and accordingly the neutralization of recoil ions via recombination with electrons will be suppressed. This results in longer lifetimes for ions and allow the use of a larger stopping volume.

The cross-sectional view of the present IGISOL chamber is shown in Fig. 1. Fission fragments from two target foils penetrate 1 μm Ti foil which separates the irradiated region from the thermalizing region. The volume of the thermalizing region is about 4.5 cm^3 which is about twice larger than that of the previous chamber. The thermalized ions emerge from the target chamber through an 1.2 mm ϕ exit hole and are guided to the skimmer as usual.

The performance of the new IGISOL chamber was examined by counting the 114 keV γ ray of ^{116}Pd ($T_{1/2} = 12.4$ s) which is produced in the 24 MeV proton-induced fission of ^{232}Th . The result is shown in Fig. 2 where the normalized yields are plotted against the beam intensity for both the new chamber and the standard chamber. The experimental conditions were the same with both cases. Efficiency for the new double chamber is about three times larger than that for the standard one. Taking into account the differences of the solid angles, this increase in efficiency corresponds to the increment factor of about 9. If plasma effect could be negligible in a double-room IGISOL chamber as expected, the normalized yield should remain constant with respect to the beam intensity. As seen in the figure, however, the normalized yield decreases with an increase of the beam intensity. The decreasing trends

for both cases are quite resemble with each other. These facts suggest that the plasma effect remains even in the double-room chamber.

Fission fragment has a large ionizing power. Therefore, the number of ion pairs produced by fission fragments may be comparable with those by proton beam. The energy deposited in helium can be regarded as a measure of the plasma effect. In the system of 24 MeV proton-induced fission of ^{232}Th , total energy deposition by 1 μA protons is estimated to about 7×10^9 MeV/s for a standard IGISOL chamber, and the contribution from fission fragments is about 17 %. On the other hand, for the new double chamber the energy deposition is about 0.8×10^9 MeV/s. If plasma effect is proportional to the energy deposition in the thermalizing volume, the plasma effect may be reduced by a factor of 9. The yield increment factor is nicely coincident with this value.

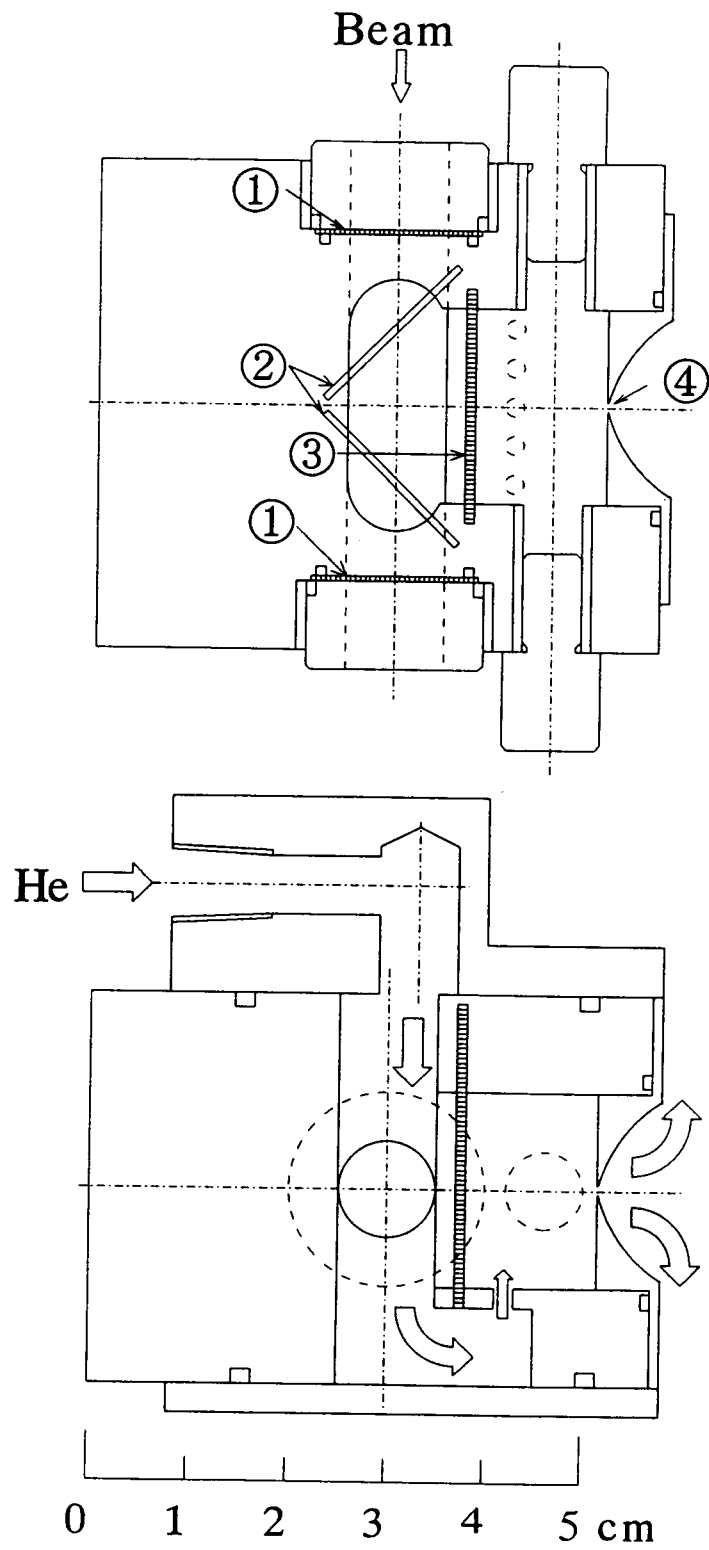


Fig. 1. Cross-sectional view of the IGISOL chamber. 1: 5 μm Havor foil, 2: target foils, 3: 1 μm Ti foil covered with tungsten mesh, 4: 1.2 mm ϕ exit hole.

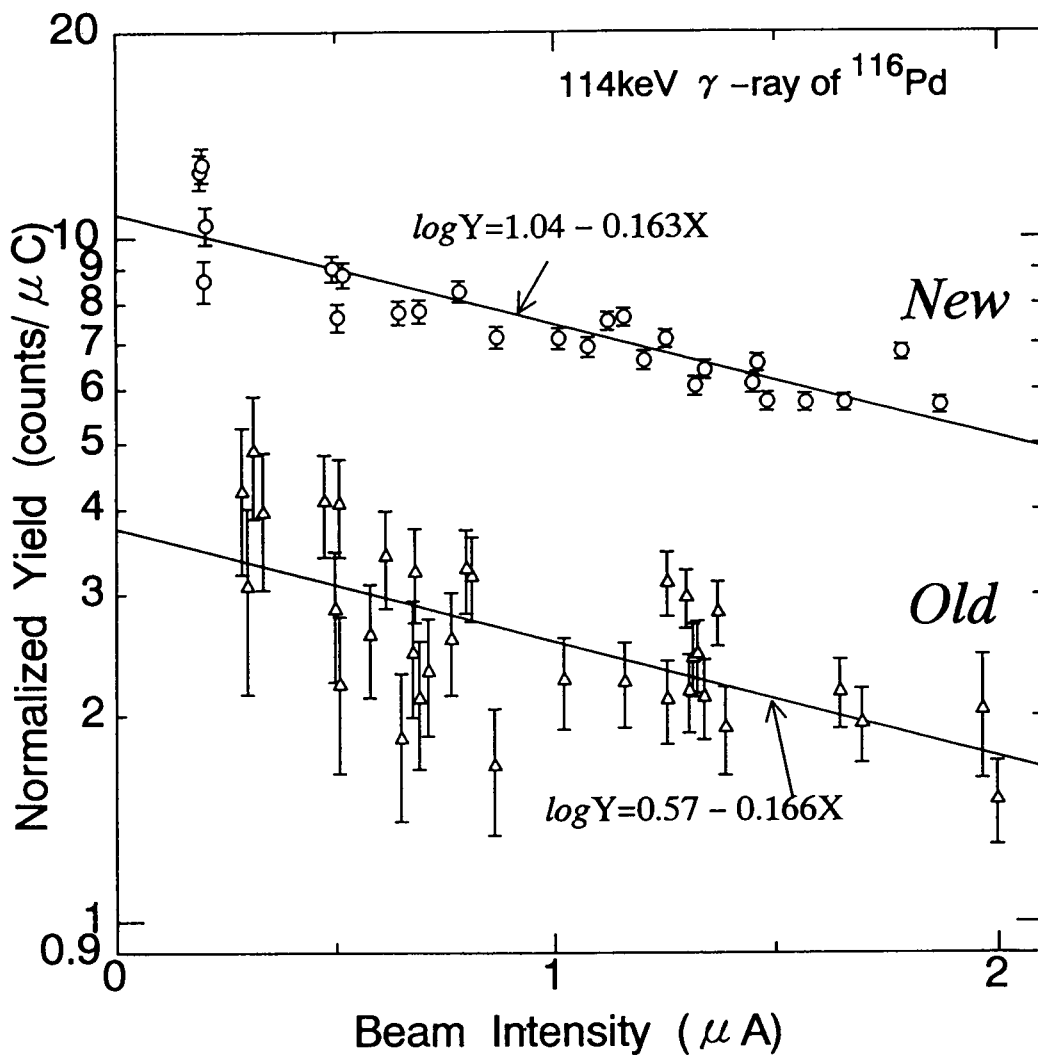


Fig. 2. Normalized yield of the 114 keV γ -ray of ^{116}Pd produced in the proton-induced fission of ^{232}Th . Old: the standard design, New: the double room chamber.