Equipment to measure He(^{12}C,^{16}O)g total cross section at Ecm = 1.0 MeV at KUTL

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The reaction $^{12}C+^{4}He \rightarrow ^{16}O+\gamma$ plays an important role in the helium burning in stars, and determines the C/O abundance ratio which significantly affects subsequent nucleosyntheses[1]. However, the $^{12}C+^{4}He$ fusion total cross section has not been determined yet in spite of over 40-year efforts [2, 3].

We plan to directly measure the total fusion cross section down to Ecm =0.7 MeV at Kyushu University Tandem accelerator Laboratory (KUTL) and to estimate the cross section at the stellar energy of 0.3MeV by extrapolation. Using a ^{12}C beam and a ^{4}He target we detect the ^{16}O recoils. From Ecm =2.4 MeV to 0.7MeV, the fusion cross section varies roughly from 100 nbarn to 1pbarn. Therefore we need a high-intensity ^{12}C beam, a thick windowless ^{4}He target, high-efficiency ^{16}O detection, and background (BG) reduction system. We have developed versatile equipment; acceleration-deceleration operation of the tandem accelerator to increase beam transmission, high-efficiency beam pulsing system, beam control system to reduce BG, a windowless He gas target of enough thickness, a large acceptance (± 2.5°) recoil mass separator, a long-time chopper for 16O recoils to reduce BG, and 16O detection system to reduce BG. [4-7]

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