Measurement of alpha elastic scattering on ^{15}O

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The γ rays emitted from novae are dominated by e$^+$-e$^-$ annihilation, of which main source is believed to be the β^+ decay of ^{18}F. The amount of ^{18}F produced in nova depends significantly on the reaction rates of ^{18}F$(p,\alpha)^{15}$O and ^{18}F$(p,\gamma)^{19}$Ne and the former one is known as the most important destructive reaction.[1)] This reaction rate is thought to be dominated by two resonances, $3/2^-$ and $3/2^+$, which are located at E_x = 6.74 MeV and 7.07 MeV in ^{19}Ne, respectively. In particular, the interference term between the strong $3/2^+$ state at 7.07 MeV and the other $3/2^+$ states around the proton threshold (6.41 MeV) is known to affect the reaction rate significantly in the astrophysically important energy region.[2)] However, the $3/2^+$ states at E_x = 6.42 and 6.45 MeV are still controversial while the $3/2^-$ state at 665 keV above the proton threshold was observed clearly.[2–6)] Therefore, to confirm the energies and J^π assignments of these resonances, the study of ^{19}Ne using ^{15}O + α would be very useful because alpha threshold energy(3.53 MeV) is much lower than the proton threshold energy(6.41 MeV).

A measurement of alpha elastic scattering on ^{15}O was performed using the thick target method, which can provide a continuous excitation function in inverse kinematics because energy loss occurs steadily through thick gas cell filled with ^{4}He. The primary beam, ^{15}N (7.0 MeV/u, 0.6 pμA), was transported from the AVF cyclotron of the RIKEN Accelerator Research Facility to the low-energy RI beam separator, called CRIB at the Center for Nuclear Study, University of Tokyo[7)] and impinged on a hydrogen gas target with a thickness of 1.09 mg/cm^2. The primary target was cooled to 90 K by liquid nitrogen in order to prevent the target window from breaking due to heat.[8)]

The secondary beam, ^{15}O, was obtained by the $p(^{15}\mathrm{N},n)^{15}$O reaction. The ^{15}O beam was selectively purified by a Wien filter system so that the beam purity was 99.9% at the focal plane (F3) of CRIB as shown in Fig. 1.

The final intensity of ^{15}O beam was 6×10^5 counts/s at the target. The F3 chamber was filled with the helium gas of 600 Torr, which was maintained at room temperature. For detecting the recoiling alpha particles, two sets of the ΔE-E telescope at 0° and 15° were installed in the F3 chamber, which was located at a distance of 200 mm from the entrance window of the chamber. The effective target thickness was 2.63 mg/cm^2. The thicknesses of two detectors are 20 μm and 480 μm, respectively. The energy of the ^{15}O beam was well-defined with 36.0±0.5 MeV after the entrance window (Mylar 20 μm-thick) of the F3 chamber, which means the measured energy was E_x=3.53-11.13 MeV in ^{19}Ne. For subtraction of the background, we performed the measurement of ^{15}O + Ar using Ar gas target. The data are being currently analyzed.

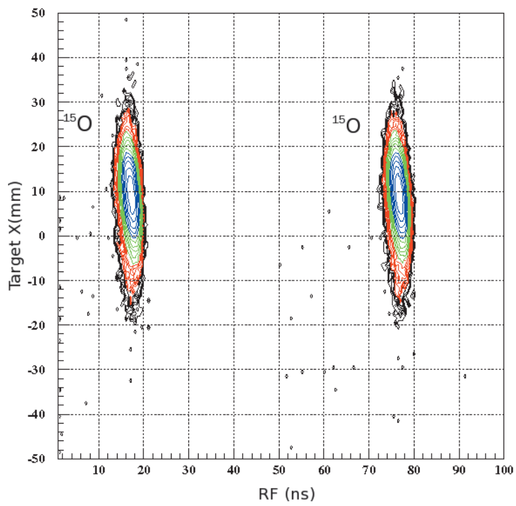

Fig. 1. Secondary beam distribution in F3 after Wien filter.

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