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…oduction of spin-controlle… …e isotope beams†

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The ability to control spin in a quantum system is a powerful tool in physics research, that holds true in the case of rare isotope (RI) beam experiments. The technique to produce spin orientation in RI beams has been playing an important role in the study on nuclear structure through the measurement of the nuclear electromagnetic moment. In this work, a novel technique, with which highly spin-aligned RI beams can be produced in a promising scheme independently of the mass difference between a projectile and a fragment, has been proposed, and the scheme involves a two-step projectile fragmentation (PF) method along with a technique of dispersion matching.

In the proposed method, a nucleus of interest is produced in the second PF reaction by one-nucleon removal from a secondary-beam particle so that the spin alignment can be high due to the simplicity of the reaction[1)]. The idea of dispersion matching[2,3)] is combined with the two-step PF. By placing a secondary target in a momentum-dispersive focal plane and a momentum slit in the double-achromatic focal plane downstream, events with the same momentum change in the second PF reaction, which form a decisive factor of the produced spin alignment, can be selected; the reaction products that acquire equal amounts of momentum change at the second PF reaction are focused onto the same position in the double-achromatic focal plane. The application of this technique to PF-induced spin alignment can prevent loss of spin alignment due to cancellation of opposite contributions from the higher and lower momentum components.

The validity of the method was demonstrated with BigRIPS at RIBF. The experimental scheme is shown in Fig 1. In the first reaction at F0, ^{33}Al was produced … …Ca beam in… …1.85 g/cm^2, … …yield for the … …^{3}Al beam. The secondary ^{33}Al beam was in… …to a second wedge-shaped aluminum target … …ean thickness of 2.70 g/cm^2, placed in the mom… …dispersive focal … includ… …ose in the isome… duced t… …gh a PF reacti…

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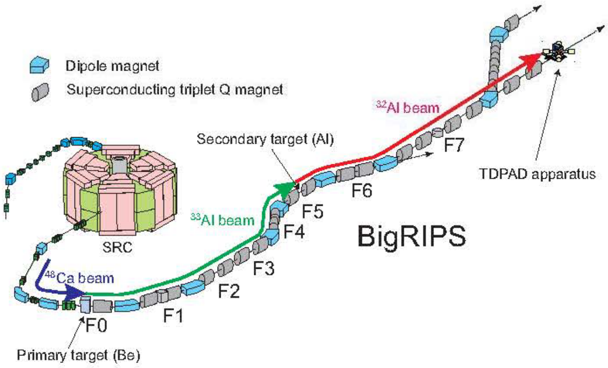

Fig. 1. Experimental scheme of the present method to produce ^{32}Al from ^{48}Ca via ^{33}Al at BigRIPS. The second PF reaction takes place in the momentum-dispersive focal plane F5.

of one neutron from ^{33}Al. The ^{32}Al beam was subsequently transported to F7, whereby the momentum dispersion between F5 to F7 was tuned to be with the same magnitude and opposite sign as that from F0 to F5 so as to cancel out the momentum dispersion from the site of the first PF reaction to F7. The slit at F7 was used to select a region of momentum change at the second PF within ±0.15% about the center of the distribution. The ^{32}Al beam was then introduced to an experimental apparatus for time-differential perturbed angular distribution (TDPAD) measurements, which was placed in a focal plane after F7. As a result of the TDPAD measurement, the degree of spin alignment in ^{32m}Al was determined to be 8(1)%.

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