Position measurement of rotating Be target for BigRIPS

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The BigRIPS separator produces secondary beams by irradiating primary beams with the target at the first focus of BigRIPS, F0. For high-intensity primary beams, a water-cooled rotating disk target is used to distribute the thermal load. An analysis of previous data found contamination synchronized with the rotation period, which could be explained by a portion of the primary beam passing through an unexpected position. To investigate this problem, measurements of the eccentricity of the rotating disk target and the relative position between the primary beam and the target were conducted in 2024.

When the primary beam is transported from the SRC to F0 through the T-course, the position and size of the beam are adjusted using an alumina fluorescent plate on the ladder-type target system at F0. A CCD camera is used to observe the image of the beam spot on the plate. The pixel resolution of the camera is 0.10 mm on the plate. The magnetic field of the T-course is adjusted accordingly. Once the adjustments are complete, the plate is removed, and two rotating disk targets[1)] are inserted. Each disk features two steps at its circumferential edge, each with an effective width of 10 mm, corresponding to three different thicknesses. At F0, the beam width is approximately 0.3 mm (1σ).[2)] To ensure that the beam components up to 6σ are contained within the effective width, any deviation of the target in the vertical (radial) direction must be 3 mm or less relative to the beam center.

The characteristics of the measured rotating disk targets are shown in Table 1. There are two flanges, each with two rotating disk target units (upper and lower disks).

First, the amplitude of vibration caused by the eccentricity of the rotating disk target, operating at a speed of 150 rotations per minute (rpm), was determined using the CCD camera. The measured vibration and its amplitude are shown in Fig. 1 and Table 1, respectively. The vibration was measured by detecting the edge of the disk using image analysis. The deviation of the waveform from a sine curve is due to systematic errors arising from the image analysis. It was observed that thicker disks exhibited larger vibration amplitudes. The investigation into the cause of the vibration is ongoing.

Second, the relative vertical position between the primary beam and the target was measured. The location of the target thickness transition can be deduced based on the two momentum peaks at the dispersive focus, F5. The measurement accuracy is 0.1 mm owing to the accuracy of the potentiometer. The deviations from the designed position are summarized in Table 1. Specifically, the deviation of the upper disk on flange A was +4.6 mm, which was larger than expected. Owing to experimental requirements, the primary beam position was vertically shifted by −1.5 mm from its usual. The shift partially explains the discrepancy, but the remaining deviation remains unexplained.

It was found that the vibration and deviations were the cause of the contamination synchronized with the rotation period. Following this study, the vertical position calibration has been implemented for each beam time, and thus, the contamination is expected to decrease.

Table 1. Combination of flange of the rotating disk targets, disk units, Be thicknesses, amplitude of vibration, and relative vertical position with respect to the beam for each primary beam in 2024. Unit is mm.

Beam	Flg.	Unit	Be Thk.	Amp.	Pos.
^{18}O	A	upper	2, 3, 4	0.34	+4.6
250 MeV/nucleon		lower	10, 15, 20	1.0	+1.3
^{70}Zn	B	upper	1, 2, 3	0.37	0.0
345 MeV/nucleon		lower	4, 6, 8	0.60	−0.8

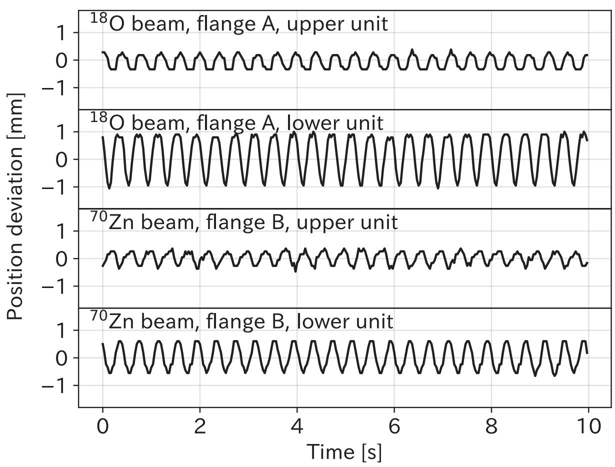

Fig. 1. Vibration of rotating disk targets at 150 rpm observed with CCD camera.

References
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