Development of dispersion matching optics in OEDO beamline

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The Optimized Energy Degrading Optics (OEDO) beamline provides potential opportunities to perform nuclear physics experiments with spatially and achromatically well-forcused low-energy RI beams[1)] or high momentum resolution by selecting a suitable ion transportation method. High-quality low-energy RI beam production has been achieved.[2)] Recently, several beamline magnets in the OEDO beamline were rearranged aiming at the realizing a high momentum resolution. To conduct nuclear spectroscopy with a resolution greater than the energy width of the incident beam, lateral and angular momentum dispersion matching techniques are essential. Figure 1 shows a designed dispersion matching ion optics from BigRIPS F3 to SHARAQ S2 foci through the OEDO beamline. The S0 intermediate focus, where a target will be inserted in a future experiment, has the largest momentum dispersion in the beamline of 14.7 m, and this momentum dispersion vanishes at the final focus, S2. We report here a study showing dispersion matching optics of the OEDO beamline.

We performed the study using an 82 MeV/nucleon triton beam produced by the BigRIPS separator from the 200 MeV/nucleon ^{4}He primary beam. Position detectors, a parallel-plate avalanche counter and a low-pressure multiwire drift chamber, were placed at the foci from F3 to S2, to measure the transfer matrix elements at each focal plane. We verified the consistency of the measured matrix elements by comparison with ion optics calculation results.

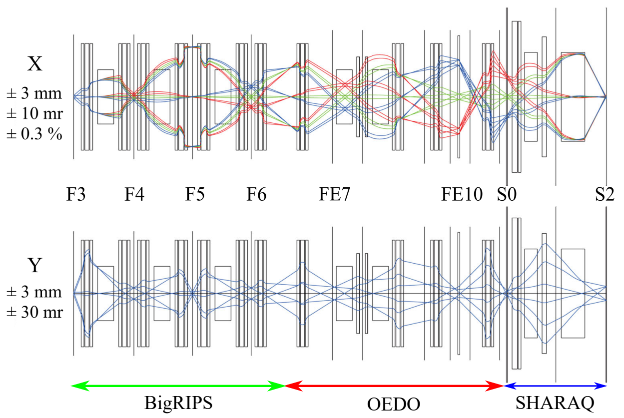

Fig. 1. Trajectories of ion beam with dispersion matching setting in BigRIPS-OEDO-SHARAQ beamline. Trajectories are calculated from first-order matrix elements.

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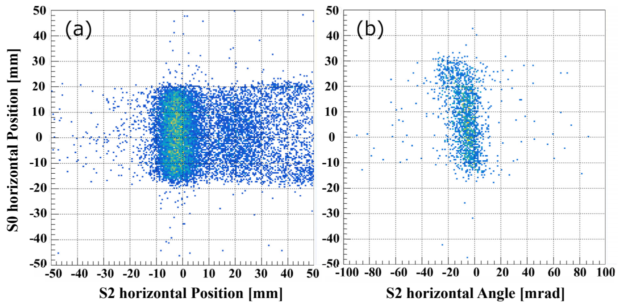

Fig. 2. (a) Correlation between S0 and S2 horizontal positions. (b) Correlation between S0 horizontal position and S2 horizontal angle. $(a|\delta)$ term is approximately 0.4 mrad/%.

By evaluating the matrix elements, the momentum dispersion at S0 was deduced as 16.3 m, which corresponds to a dispersion of 0.025 mm/% and satisfies the lateral dispersion matching condition with the SHARAQ spectrometer. Figure 2(a) shows that there is no correlation between the horizontal position (momentum dispersion) at S0 and that at S2 and therefore, the condition of momentum dispersion matching is fulfilled. Figure 2(b) shows the correlation between the horizontal position (momentum dispersion) at S0 and the horizontal angle at S2, which suggests that angular dispersion matching is efficiently satisfied. We conclude that angular momentum dispersion matching is also achieved at S2.

Consequently, we achieved dispersion matching ion transportation through the OEDO beamline. Using this ion-optical mode, we plan to conduct an approved experimental program of direct mass measurements of very rare RI nuclei.

References
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