Commissioning of the OEDO beamline

S. Michimasa,[*1] S. Shimoura,[*1] K. Yamada,[*2] S. Ota,[*1] M. Dozono,[*1] N. Imai,[*1] J. W. Hwang,[*1] M. Matsushita,[*1] K. Yoshida,[*2] Y. Yanagisawa,[*2] K. Kusaka,[*2] M. Ohtake,[*2] D. S. Ahn,[*2] O. Beliuskina,[*1] N. Chiga,[*2] K. Chikaato,[*3] N. Fukuda,[*2] S. Hayakawa,[*1] E. Ideguchi,[*4] K. Iribe,[*5] C. Iwamoto,[*1] S. Kawase,[*6] K. Kawata,[*1] N. Kitamura,[*1] S. Masuoka,[*1] H. Miyatake,[*7] D. Nagae,[*2] S. Naimi,[*2] R. Nakajima,[*1] T. Nakamura,[*8] K. Nakano,[*6] M. Nakano,[*9] S. Ohmika,[*2] H. Otsu,[*2] H. Sakurai,[*2,*10] S. Sato,[*9] P. Schrock,[*1] H. Shimizu,[*1] Y. Shimizu,[*2] T. Sumikama,[*2] X. Sun,[*2] D. Suzuki,[*2] H. Suzuki,[*2] M. Takaki,[*1] M. Takechi,[*3] H. Takeda,[*2] S. Takeuchi,[*8] T. Teranishi,[*5] R. Tsunoda,[*1] H. Wang,[*2] Y. Watanabe,[*6] Y. X. Watanabe,[*7] K. Wimmer,[*10,*2] K. Yako,[*1] H. Yamaguchi,[*1] L. Yang,[*1] and H. Yoshida[*5]

The OEDO system was proposed to produce focused slow-down radioactive-ion (RI) beams in RIBF[1] and has been installed in the High-Resolution Beamline (HRB) in the end of fiscal year 2016.[2] The commissioning of the OEDO beamline has been performed in June 15–21, 2017.

A schematic view of the OEDO beamline and detector setup is shown in Fig. 1. The main components of the OEDO system are a radio-frequency deflector (RFD) synchronized with the cyclotron's RF and 2 sets of superconducting triplet quadrupole (STQ) magnets. For matching to the ion optics of the OEDO system, the momentum dispersion from the BigRIPS to FE9 was tuned to be 13 mm/% at FE9. An Al degrader at FE9 slows down RIs to less than 50 MeV/nucleon. The inset of Fig. 1 shows calculated ion trajectories of the OEDO system on the horizontal plane. The first STQ in the figure provides point-to-parallel transport, resulting in a strong correlation between the angular and time components of the beam. The second STQ works as inverse transformation of the first one. The RFD periodically changes the RI's horizontal angles in order to align them in parallel. The aligned RIs focus at FE11 through the central trajectory in the second half of the OEDO system.

In the commissioning run, long-lived fission products ^{79}Se and ^{107}Pd were produced from a 345-MeV/nucleon ^{238}U beam. The beam energy of ^{79}Se (^{107}Pd) was tuned to be 170 (180) MeV/nucleon in BigRIPS and 45 ± 2 (33 ± 0.5) MeV/nucleon at FE11 after energy reduction by degraders and detectors.

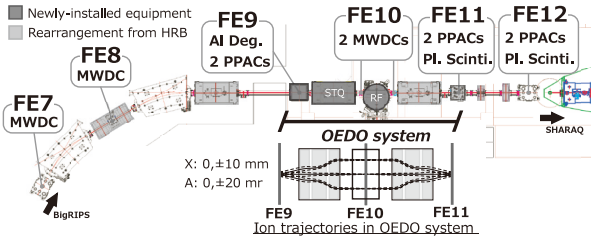

Fig. 1. Schematic view of the OEDO beamline. The ion optics in the OEDO system are also shown.

Figure 2 displays correlations between the arrival timing at FE10 and the horizontal hit position at FE11, where Figs. 2(a) and (b) show those without and with RFD operation, respectively. The figures demonstrate that the RFD focuses the ^{79}Se beam and can adjust the beam position. The FE11 horizontal beam spot size was reduced from 25 mm to 15 mm in FWHM, as shown in Fig. 3.

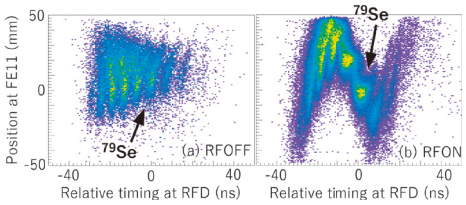

Fig. 2. Ion-optical effect of RFD for beam focusing.

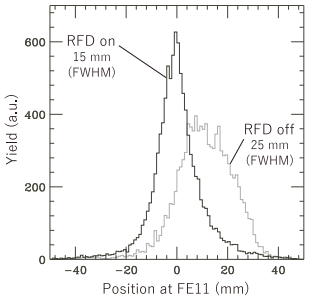

Fig. 3. Beam focusing of ^{79}Se at FE11 with and without RFD.

The OEDO beamline was successfully launched. Further data analysis is ongoing to improve the transmission of the beamline and to develop an effective tuning procedure for upcoming physics experiments.

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*1 Center for Nuclear Study, the University of Tokyo
*2 RIKEN Nishina Center
*3 Dept. of Physics, Niigata University
*4 RCNP, Osaka University
*5 Dept. of Physics, Kyushu University
*6 Dept. of Advanced Energy Eng. Sci., Kyushu University
*7 Wako Nuclear Science Center, KEK
*8 Dept. of Physics, Tokyo Institute Technology
*9 Dept. of Physics, Rikkyo University
*10 Dept. of Physics, The University of Tokyo

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