Production cross section measurements of Ne isotopes with a ^{48}Ca beam

D. S. Ahn,[*1] N. Fukuda,[*1] H. Suzuki,[*1] Y. Shimizu,[*1] H. Takeda,[*1] T. Sumikama,[*1] D. Murai,[*1,*2] J. Amano,[*1,*2] N. Inabe,[*1] K. Yoshida,[*1] Y. Yanagisawa,[*1] K. Kusaka,[*1] M . Ohtake,[*1] T. Komatsubara,[*1] H. Sato,[*1] H. Ueno,[*1] and T. Kubo[*1,*3]

The systematic trends of production cross sections are necessary to predict the production rates of rare isotopes, and important to search for new isotopes and the neutron drip line. Comparison of expected and measured yields is important to ascertain whether bound states exist in isotopes such as ^{39}Na. Expected yields for ^{39}Na (Z = 11) can be estimated from the neighboring isotopes. We measured the production cross sections of very neutron-rich Ne (Z = 10) isotopes. In the previous experiment,[1] the cross sections for many Ne isotopes were obtained with low transmission (2~5% in the worst cases). In this experiment, the production cross sections of neutron-rich $^{29\text{-}34}$Ne isotopes were measured with optimized settings for each isotope. As each isotope passed through a central orbit, a high transmission was achieved.

Ne isotopes were produced by the projectile fragmentation of a ^{48}Ca beam at an energy of 345 MeV/nucleon using the BigRIPS separator[2] of RIKEN RIBF. The same target (Be: 20 mm) and the same thickness degraders were used for both F1 (Al: 15 mm) and F5 (Al: 8 mm). The F5 degrader was used to reject contaminants in the form of light particles. A thick collimator installed before the F2 slits was developed as shown in Fig. 1. The collimator was made of an SUS material with a 50-cm thickness to block most contaminants, including tritons and other light particles. The aperture of the collimator was designed with horizontal and vertical angular acceptances of ±20 mrad and ±30 mrad, respectively, which correspond to ±7.5 mm in the horizontal direction at the F2 focal plane. Additional iron blocks were also installed to cover both sides of the collimator.

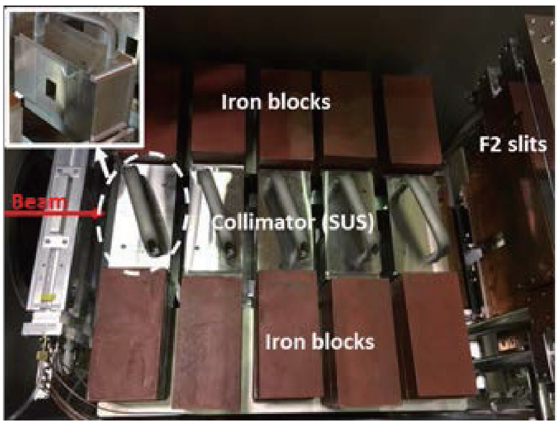

Fig 1. Schematic view of collimator and iron blocks at F2.

*1 RIKEN Nishina Center
*2 Department of Physics, Rikkyo University
*3 FRIB/NSCL, Michigan State University

Particle identification was performed using the TOF-$B\rho$-ΔE method.[3] Fig. 2 shows the production cross sections of neutron-rich Ne isotopes. The experimental results obtained in the 2008-2010[1] and 2014 experiments are also shown in Fig. 2. Different collimators were used in the previous experiments as follows: SUS material with 30-cm thickness for the 2008-2010[1] experiment and 45-cm-thick iron blocks with a large aperture for the 2014 experiment. The black line represents an empirical formula of the EPAX 2.15[4] parameterizations in the LISE^{++} calculation.[5] The present results are in good agreement with both the previous experimental results and the predictions. However, the measured production cross sections of the ^{31,34}Ne isotopes are slightly underestimated.

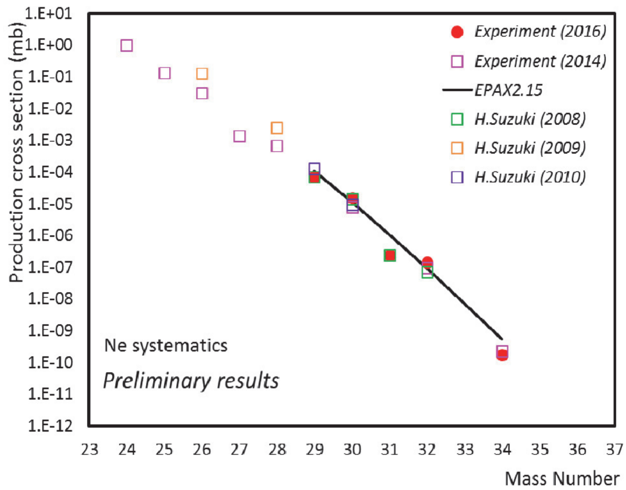

Fig. 2. Preliminary results of production cross sections of very neutron-rich Ne isotopes up to the heaviest known isotope, ^{34}Ne. The filled red circles represent the experimental results obtained from the 2016 experiment. The green, orange, violet, and pink rectangles represent the experimental results obtained from the 2008,[1] 2009,[1] 2010,[1] and 2014 experiments, respectively. The experimental measurements are compared with the EPAX 2.15 parameterizations indicated by the black line.

References

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