New isotope search conducted concurrently with BRIKEN campaign

Y. Shimizu,[*1] N. Fukuda,[*1] K. P. Rykaczewski,[*2] R. K. Grzywacz,[*3] J. L. Tain,[*4] I. Dillmann,[*5] S. Nishimura,[*1] H. Takeda,[*1] H. Suzuki,[*1] D. S. Ahn,[*1] N. Inabe,[*1] K. Yoshida,[*1] H. Ueno,[*1] N. T. Brewer,[*2] B. C. Rasco,[*2] D. W. Stracener,[*2] and J. M. Allmond[*2] for the BRIKEN collaboration

In order to measure new β-delayed neutron emission properties for near doubly magic nucleus ^{78}Ni using the world-largest array of ^{3}He counters BRIKEN,[1)] the experiment was performed at the RIKEN Nishina Center RI Beam Factory (RIBF). The nuclei of interst were produced by the in-flight fission of a 345 MeV/nucleon ^{238}U beam colliding with a 3.87-mm-thick Be target. The primary beam intensity was 56.6 particle nA on average. Fission fragments were separated and identified using the superconducting in-flight separator BigRIPS.[2)] In order to separate and purify the RI beams, two wedge-shaped energy degraders were placed at the F1 and F5 dispersive foci. The typical counting rate at the F3 and F7 achromatic foci were 545.4 Hz and 102.4 Hz, respectively. Table 1 summarizes the experimental conditions. The BigRIPS setting in this work included regions of new isotopes on the more neutron rich side. This allowed us to search for new isotopes in parallel with the measurements of the BRIKEN campaign.

Table 1. Summary of the experimental conditions.

Target (mm)	Be 3.87
Bρ [a] (Tm)	8.272
Degrader at F1 (mm)	Al 5.01
Degrader at F5 (mm)	Al 3.45
F1 slit (mm)	+58.0 / −64.2
F2 slit (mm)	+20.0 / −20.0
F5 slit (mm)	+110.0 / −110.0
F7 slit (mm)	+25.0 / −25.0
Central particle	^{82}Cu
Irradiation time (h)	191.8
Live time of DAQ (%)	95.5
Trigger rate (Hz)	97.8
Total dose	2.44×10^{17}

[a] The values from the magnetic fields of the first dipole magnet.

Particle identification (PID) was performed using the ΔE-TOF-Bρ method in which the energy loss (ΔE), time of flight (TOF), and magnetic rigidity (Bρ) were measured to allow the event-by-event determination of atomic number Z and mass-to-charge ratio A/Q of fragments.[3)] The PID was confirmed by measuring the delayed γ-rays emitted from short-lived isomers, such as ^{92}Br and ^{94}Br, by using two clover-type high-purity germanium detectors placed at the F7 achromatic focus; this technique is called isomer tagging.[4)]

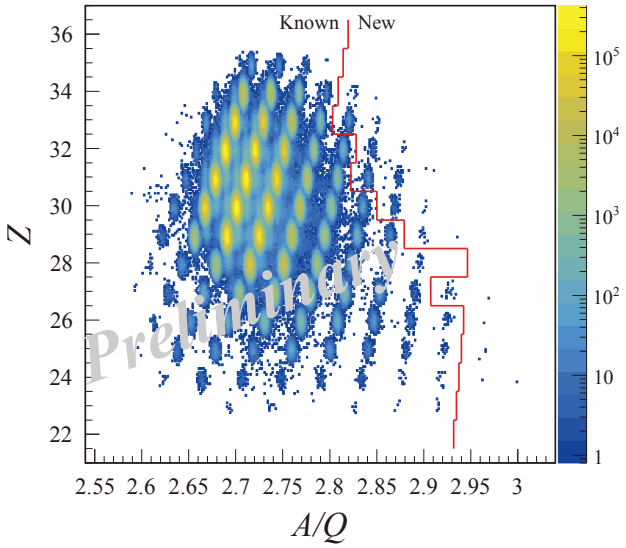

Fig. 1. Two-dimensional PID plot of Z versus A/Q. Red line indicates the limit of known isotopes[5–7)] as of January 2018.

Figure 1 shows a two-dimensional PID plot of Z versus A/Q. The solid red line indicates the limit of identified isotopes[5–7)] as of January 2018. The relative root mean square (rms) Z resolution and the relative rms A/Q resolution were typically 0.61% and 0.081%, respectively. We can see some candidates for new isotopes such as ^{79}Co, ^{84}Cu, ^{86}Zn, and ^{93}As.

Detailed analysis is currently in progress.[8)]

*1 RIKEN Nishina Center
*2 Oak Ridge National Laboratory (ORNL)
*3 Department of Physics and Astronomy, University of Tennessee
*4 Instituto de Física Corpuscular, CSIC-Universidad de Valencia
*5 TRIUMF

References

1) A. Tarifeño-Saldivia *et al.*, J. Instrum. **12**, 04006 (2017).
2) T. Kubo, Nucl. Instrum. Methods Phys. Res. B **204**, 97 (2003).
3) N. Fukuda *et al.*, Nucl. Instrum. Methods Phys. Res. B **317**, 323 (2013).
4) R. K. Grzywacz *et al.*, Phys. Lett. B **355**, 439 (1995).
5) M. Bernas *et al.*, Phys. Lett. B **415**, 111 (1997).
6) T. Ohnishi *et al.*, J. Phys. Soc. Jpn. **79**, 073201 (2010).
7) T. Sumikama *et al.*, Phys. Rev. C **95**, 051601R (2017).
8) K. P. Rykaczewski *et al.*, in this report.