Identification of 18 new neutron-rich isotopes produced in the EURICA uranium beam campaign

Y. Shimizu,[*1] T. Kubo,[*1] N. Fukuda,[*1] N. Inabe,[*1] D. Kameda,[*1] H. Sato,[*1] H. Suzuki,[*1] H. Takeda,[*1] K. Yoshida,[*1] H. Baba,[*1] F. Browne,[*1,*2] P. Doornebal,[*1] G. Gey,[*1,*3,*4] T. Isobe,[*1] A. Jungclaus,[*5] Z. Li,[*6] G. Lorusso,[*1] S. Nishimura,[*1] G. Simpson,[*3] P.-A. Söderström,[*1] T. Sumikama,[*7] J. Taprogge,[*1,*5,*8] Zs. Vajta,[*1,*9] H. Watanabe,[*1,*10,*11] J. Wu,[*1,*6] and Z.Y. Xu[*12]

The EUROBALL RIKEN Cluster Array (EURICA) collaboration aims to conduct isomer and β-delayed γ-ray spectroscopy of several hundred nuclei far from stability. In 2012, at the RIKEN Nishina Center RI Beam Factory (RIBF), the EURICA uranium beam campaign was been conducted to investigate isomeric decays from very neutron-rich nuclei and their β decays[1–3].

In the EURICA uranium beam campaign, the nuclei of interest were produced by the in-flight fission of 345 MeV/nucleon ^{238}U beam colliding with a 2.92-mm-thick Be target. The primary beam intensity was 8.24 particle nA on average. Table 1 summarizes the two settings used in the EURICA uranium beam campaign. Fission fragments were identified by using the superconducting in-flight separator BigRIPS[4] and the ZD spectrometer. The particle identification (PID) was performed using the ΔE-TOF-$B\rho$ method, which allows the event-by-event determination of the atomic number Z and mass-to-charge ratio A/Q of fragments[5].

Table 1. Summary of the experimental conditions.

Setting	^{136}Sn	^{128}Pd
Target (mm)	Be 2.92	Be 2.92
Bρ [a] (Tm)	8.004	7.391
Degrader at F1 (mm)	Al 2.82	Al 2.82
Degrader at F5 (mm)	Al 2.46	Al 2.46
F1 slit (mm)	+43.0/−64.2	+22.0/−64.2
F2 slit (mm)	+12.0/−18.0	+8.0/−12.0
Irradiation time (h)	99.6	102.9

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

Figure 1 shows a two-dimensional PID plot of Z versus A/Q for the ^{136}Sn setting. The solid red line indicates the limit of known isotopes. The relative root mean square (rms) Z resolution and the relative rms A/Q resolution achieved were typically 0.38 and 0.037%, respectively, for the ^{136}Sn setting. Thanks to the excellent resolution in A/Q, we have produced and identified the following 18 new neutron-rich isotopes: ^{118}Mo, ^{121}Tc, ^{122}Tc, ^{125}Ru, ^{127}Rh, ^{129,130,131}Pd, ^{132}Ag, ^{134}Cd, ^{136,137}In, ^{139,140}Sn, ^{141,142}Sb, ^{144}Te, and ^{146}I. A detailed analysis is currently in progress.

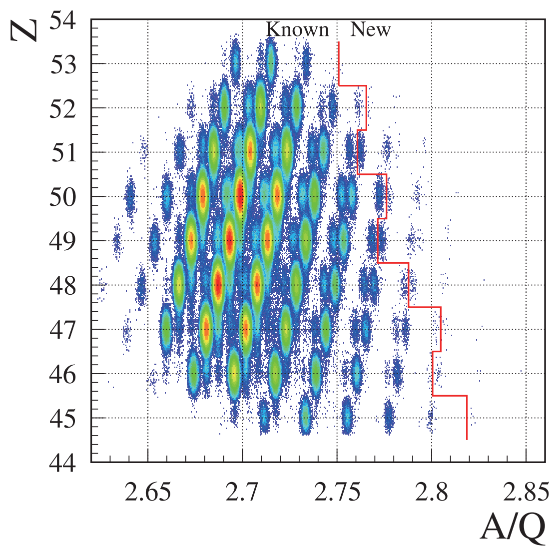

Fig. 1. Two-dimensional PID plot of Z versus A/Q for the ^{136}Sn setting. Red line indicates the limit of known isotopes.

*1 RIKEN Nishina Center
*2 School of Computing, Engineering and Mathematics, University of Brighton
*3 LPSC, Grenoble
*4 Instituto de Estructura de la Materia
*5 IEM-CSIC, Madrid, Spain
*6 Department of Physics, Peking University
*7 Department of Physics, Tohoku University
*8 Universidad Autónoma de Madrid, Spain
*9 MTA Atomki, Debrecen, Hungary
*10 International Research Center for Nuclei and Particles in the Cosmos, Beihang University
*11 School of Physics and Nuclear Energy Engineering, Beihang University
*12 Department of Physics, University of Tokyo

References

1) G. Lorusso *et al.*: RIKEN Accel. Prog. Rep. **46**, x (2013).
2) G.S. Simpson *et al.*: RIKEN Accel. Prog. Rep. **46**, 22 (2013).
3) H. Watanabe *et al.*: Phys. Rev. Lett. **111**, 152501 (2013).
4) T. Kubo *et al.*: Nucl. Instr. and Meth. **B 204**, 97 (2003).
5) N. Fukuda *et al.*: Nucl. Instr. and Meth. **B 317**, 323 (2013).