RI beam production at BigRIPS in 2017

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The radioactive isotope (RI) beam production at the BigRIPS fragment separator[1] in 2017 is presented here. Table 1 summarizes the experimental programs that involved the use of the BigRIPS separator during this period and the RI beams produced for each experiment.

The spring beam time started with a ^{48}Ca primary beam in March. The experiment was performed to search for the existence of a new ^{39}Na isotope and to determine the neutron dripline of neon isotopes.[2] The parasite BRIKEN experiment was performed to measure the multi-neutron emission probabilities.

Four experiments were conducted in the ^{70}Zn beam campaign that was started in April. The ^{40,50,52}Ca beams were delivered to the SAMURAI spectrometer to measure the electric dipole response of the neutron-rich Ca isotopes. The experiment to search for new neutron-rich isotopes was performed with the BigRIPS separator in the region of ^{60}Ca isotope.[3] A total of 8 new isotopes was identified in the preliminary analysis. The SEASTER experiment was performed with ^{63}V, ^{57}Sc, ^{53}K to understand the evolution of the shell structure towards the dripline.

Seven experiments were conducted in the ^{238}U beam campaign that was started in May. The ^{167}Sm, ^{149}Xe, ^{130}Ag, ^{84}Zn beams were delivered to the ZeroDegree spectrometer for BRIKEN experiments. The ^{200}W beam was produced for neutron-rich nuclei around the $N = 126$ using a projectile-fragmentation of the ^{238}U beam as a machine study.[4] The ^{79}Se and ^{107}Pd beams were produced for OEDO commissioning with the ImPACT program.

The spring beam time ended with an ^{18}O beam campaign, in which three experiments were performed. The ^{1}H and ^{6,8}He beams were produced for the SAMURAI experiment.

In the autumn beam time, the ^{238}U beam campaign was started in October with eight experiments. The ^{93}Zr, ^{107}Pd, and ^{77,79}Se isotope beams were provided with the ImPACT program. The BRIKEN experiments were performed to measure the multi-neutron emission probabilities and to search for new isotopes.[5] An experiment with two-step reaction scheme was performed to measure the production cross sections of the $^{125-128}$Pd beam from the ^{132}Sn beam using the BigRIPS and the ZeroDegree spectrometer.[6] The

Table 1. List of experimental programs and RI beams produced at the BigRIPS separator in 2017.

Primary beam (Period)	Proposal No.	Course	RI beams
^{48}Ca 345 MeV/nucleon (Mar. 30 – Apr. 2)	DA16-01-01	ZeroDegree	^{39}Na, ^{36}Ne
	PE16-04	ZeroDegree	^{40}Mg,^{37}Na (parasite experiment)
^{70}Zn 345 MeV/nucleon (Apr. 11 – May 15)	NP1312-SAMURAI9R1-01	SAMURAI	^{44,50,52}Ca
	NP1406-RIBF44R1-02	BigRIPS	$^{52-54}$Ar, ^{53}Cl, ^{57}K, ^{52,54,60}Ca, ^{50}S
	NP1512-SAMURAI38R1&39R2-01	SAMURAI	^{63}V, ^{57}Sc, ^{53}K
	DA17-01-01	SAMURAI	^{53}K
^{238}U 345 MeV/nucleon (May 30 – Jun. 21)	NP1512-RIBF139-02 NP1406-RIBF127R1-02 NP1406-RIBF128-02 NP1612-RIBF148-01	ZeroDegree	^{167}Sm, ^{149}Xe, ^{130}Ag, ^{84}Zn
	MS-EXP17-02	BigRIPS	^{200}W
	MS-EXP17-04	ZeroDegree	^{238}U (primary beam)
	IMPACT17-01	SHARAQ	^{79}Se, ^{107}Pd
^{18}O 220 MeV/nucleon (Jun. 24 – July 14)	NP1406-SAMURAI19R1-01	SAMURAI	^{1}H, ^{6,8}He
	NP1512-SAMURAI37-01	SAMURAI	^{6,8}He
	NP1512-SAMURAI34-01	SAMURAI	^{1}H, ^{8}He
^{238}U 345 MeV/nucleon (Oct. 21 – Nov. 30)	IMPACT17-02-01	SHARAQ	^{93}Zr, ^{107}Pd
	DA17-02-01	ZeroDegree	^{82}Cu
	IMPACT17-02-02	SHARAQ	^{77,79}Se
	MS-EXP17-03	PALIS	^{66}Cu
	NP1512-RIBF139-03 NP1612-RIBF148-02	ZeroDegree	^{100}Br, ^{102}Sr, ^{106}Zr, ^{112}Mo, ^{115}Nb
	NP1306-RIBF102-01	ZeroDegree	^{126,128}Pd, ^{132}Sn
	MS-EXP17-05	Rare-RI Ring	^{78}Ge

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Table 2. Number of experiments performed using RI beams in each year.

Year	^{238}U	^{124}Xe	^{86}Kr	^{78}Kr	^{70}Zn	^{48}Ca	^{18}O	^{16}O	^{14}N	^{4}He	^{2}H	Yearly total
2007	4		1									5
2008	2					4						6
2009	3					3			3	1		10
2010						10	1		2		1	14
2011	4	2					2					8
2012	6	3			1	4	6					20
2013	4	2					3					9
2014	11				1	3		1			1	17
2015	15			6		4					1	26
2016	13	1				6	2					22
2017	13				4	2	3					22
Total	75	8	1	6	6	36	17	1	5	1	3	159

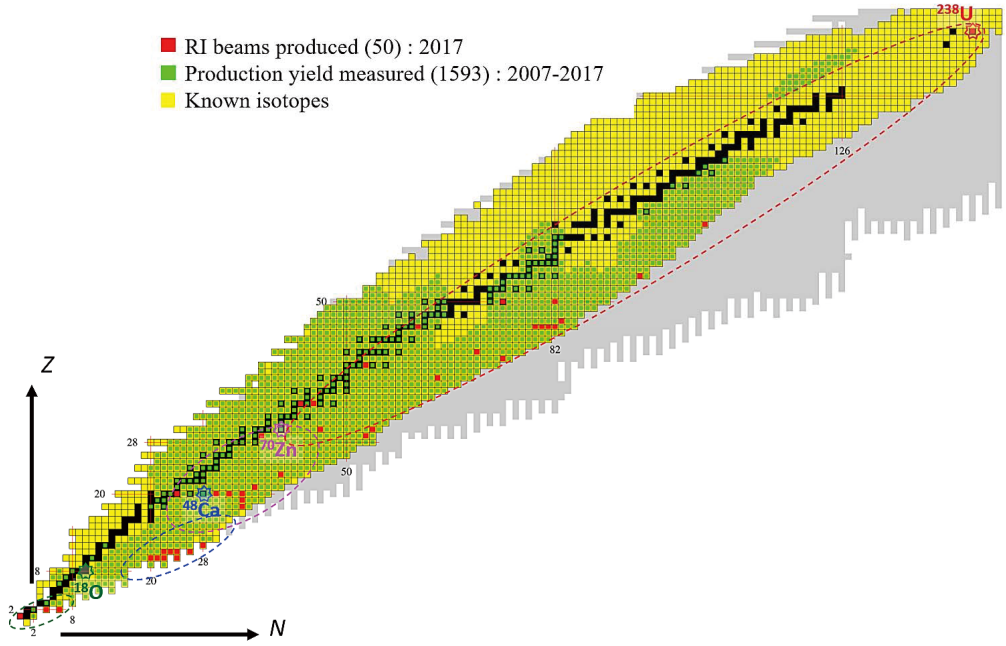

Fig. 1. RI beams produced in 2017 and the production yield measured from March 2007 to December 2017 at the BigRIPS separator.

autumn beam time ended with a machine study of the Rare-RI Ring experiment using the ^{78}Ge beam.

The number of experiments using the RI beams at the BigRIPS separator is summarized in Table 2 for various primary beams in each year. A total of 159 experiments have been performed so far. Figure 1 shows the RI beams produced in 2017 at the BigRIPS separator on the chart of nuclides with red squares.The number of RI beams produced in 2017 is 50. The production yields for 1593 RI beams were measured from March 2007 to December 2017, and they are indicated using green color. The yellow color indicates the known isotopes.

References

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