RI beam production at BigRIPS in 2021

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Radioactive isotope (RI) beam production at the BigRIPS fragment separator[1] in 2021 is presented here. Table 1 summarizes the experimental programs that involved the use of the BigRIPS separator in this period and the RI beams produced for each experiment.

In the spring beamtime, the ^{238}U beam campaign was conducted in the first half, followed by the light-ion beam campaign in the second half.

The ^{238}U beam campaign started in April. A ^{80}Zn beam was produced for a HiCARI experiment using ZeroDegree spectrometer to study γ-ray spectroscopy in the vicinity of double-magic ^{78}Ni. During this experiment, mass measurements with a multi-reflection time-of-flight mass spectrometer (MRTOF-MS) located downstream of ZeroDegree spectrometer were performed symbiotically. ^{74}Ni, ^{75}Ni, and ^{76}Ni beams were produced for mass measurements using the Rare RI Ring. Two BRIKEN experiments were then conducted. A ^{156}La beam was produced to measure masses, half-lives, and β-delayed neutron emission probabilities. An ^{202}Os beam was produced to study β-decay spectroscopy in the vicinity of the $N = 126$ closed shell. The symbiotic MRTOF-MS experiment was performed again during these BRIKEN experiments. At the end of the ^{238}U campaign, two machine studies were performed; an in-separator two-step method to produce and separate neutron-rich mid-heavy RI beams with a ^{133}Sn beam[2] and an automation tuning of the primary beamline using a machine learning technique with a ^{238}U primary beam.

The light-ion beam campaign was started in May. In the first two experiments, search for the double Gamow-Teller giant resonances (DGTGR) in $\beta\beta$-decay with a ^{12}C primary beam and high precision spectroscopy of pionic atoms with a ^{2}H primary beam, the BigRIPS F0-F5 section was used as a spectrometer in the dispersion matched operation to analyze the momentum of ejected particles produced at the F0 target. ^{8}Li, ^{9}Li, ^{10}Be, ^{12}B, and ^{3}He beams produced with the ^{12}C primary beam were used for the ion-optical tuning and detector setup for these experiments. The DGTGR experiment was performed with ^{12}B and ^{12}Be settings. After switching to the ^{2}H primary beam, the pionic atom experiment was performed with the ^{3}He setting.

Table 1. List of experimental programs with RI beams produced at the BigRIPS separator in 2021.

Primary beam (Period)	Proposal No.	Spokesperson	Course	RI beams
^{238}U 345 MeV/nucleon (Apr. 8 – May 5)	NP1912-RIBF181-02	R. Taniuchi	ZeroDegree	^{80}Zn
	PE21-01	M. Wada	ZeroDegree	(symbiotic)
	NP1612-RIRING02-02	A. Ozawa	Rare RI Ring	^{74}Ni, ^{75}Ni, ^{76}Ni
	NP1612-RIBF148-07	G. Kiss	ZeroDegree	^{156}La
	NP1712-RIBF158-02	J. Wu	ZeroDegree	^{202}Os
	PE21-02	M. Wada	ZeroDegree	(symbiotic)
	MS-EXP21-01	H. Suzuki	ZeroDegree	^{133}Sn
	MS-EXP21-03	T. Nishi	BigRIPS	(primary)
^{12}C 250 MeV/nucleon (May 20 – May 29)	NP1712-RIBF141R1-01	T. Uesaka	ZeroDegree	^{8}Li, ^{9}Li, ^{10}Be, ^{12}Be, ^{12}B
	NP1912-RIBF135R1-01	K. Itahashi	BigRIPS	^{3}He
^{2}H 250 MeV/nucleon (May 31 – Jun. 9)	NP1912-RIBF135R1-02	K. Itahashi	BigRIPS	^{3}He
^{4}He 200 MeV/nucleon (Jun. 12 – Jun. 21)	NP1712-SHARAQ11-01	K. Miki	SHARAQ	^{3}H
	MS-EXP21-06	S. Michimasa	SHARAQ	^{3}H
	MS-EXP21-07	K. Yoshida	BigRIPS	^{3}H
^{238}U 345 MeV/nucleon (Nov. 20 – Dec. 3)	DA21-04-02	H. Otsu	ZeroDegree	(BigRIPS tuning only)
	NP2012-RIBF199-01	M. Wada	ZeroDegree	^{203}Re
	NP2012-RIBF202-01	M. Rosenbusch	ZeroDegree	^{79}Ni
	INSPECTION21-03	K. Tanaka	BigRIPS	^{75}Zn
	NP1712-RIBF166-05	T. Sonoda	PALIS	^{191}Bi
	NP1712-RIRING01R1-02	S. Naimi	Rare RI Ring	^{124}Pd, ^{125}Pd
	NP2012-RIBF202-02	M. Rosenbusch	ZeroDegree	^{79}Ni

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After switching to a ^{4}He primary beam, a search for three-neutron resonant states was performed with a ^{3}H beam. A machine study for the development of a dispersion matched beam transport of the OEDO beamline was conducted using another ^{3}H beam setting. At the end of the light-ion beam campaign, a machine study was conducted with the two ^{3}H beams and the ^{4}He primary beam to investigate the vertical (Y) axis misalignment.[3)]

In the autumn beamtime, the ^{238}U campaign was conducted again from November. During the BigRIPS tuning, the performance of a newly developed ionization chamber specialized in high-Z beams installed at F7 was examined with the ^{238}U primary beam.[4)] The productions of an ^{237}Np beam and a reduced-energy uranium beam were also tested. Two MRTOF-MS experiments were then performed in ^{203}Re and ^{79}Ni centered beam settings, respectively. A facility inspection was conducted using a ^{75}Zn beam. A PALIS experiment was then performed with a ^{191}Bi beam, and a Rare RI Ring experiment was conducted with ^{124}Pd and ^{125}Pd beams. The auto-focusing and auto-centering systems were tested[5)] in the BigRIPS tuning for the next MRTOF-MS experiment. During the MRTOF-MS experiment with the ^{79}Ni beam, a serious problem occurred on the refrigerator of the BigRIPS separator making it inoperable. The remainder of the scheduled experiments were therefore canceled.

RI beam production at BigRIPS from the start of operation in March 2007 is summarized in our database[6)] available at `https://ribeam.riken.jp/`.

References

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