

Operation report on ring cyclotrons in the RIBF accelerator complex

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The operation report of the ring cyclotrons in the RIBF accelerator complex from January to December 2023 is provided. Table 1 presents data on beam intensity, beam service time, and the availability of the ring cyclotrons during this period. The information is classified by acceleration mode, beam particle, energy, and beam course. However, due to a vacuum leak in the SRC extraction line on December 5, 2022, and subsequent trouble with its refrigeration system, the RIBF experiment could not be conducted during this term. As a result, only the RARF experiments were targeted for aggregation. The availability is defined as the ratio of the actual beam service time to the requested beam service time, serving as an index of the stable operation of accelerators. For calculating each availability, requested times were identified with actual times for beam service times that were completed earlier than requested. Additionally, multiple experiments supplying identical beams are considered as one and presented in a row.

The total actual beam service time was 1056.6 hours, with an overall availability of 99.3%. However, during the ¹²C 135 MeV/nucleon experiment conducted in December, the experiment was suspended for 7.6 hours ow-

ing to a problem with the electrostatic inflection channel (EIC) of RRC. Upon investigation, a failure was found in the high-voltage cable, prompting its replacement with a spare part and to restore the system. Apart from this incident, no other major problem occurred, and stable beams were supplied as usual.

The vacuum leak in the SRC extraction line, previously mentioned, has been successfully repaired. To prevent a recurrence of the issue, we are implementing measures including maintenance work, such as the installation of new beam baffles and updates to the beam-interlock system. Additionally, repair work is currently in progress on the refrigeration system, including the production of necessary parts. We are planning to resume RIBF operations next spring.

For further details regarding these operations and other developments or issues, refer to Refs. 1) and 2).

References

- 1) M. Nishimura *et al.*, Proc. of PASJ2023, Funabashi, Japan, August, 2023, TWSP12, pp. 1049–1053.
- 2) R. Koyama *et al.*, Proc. of PASJ2023, Funabashi, Japan, August, 2023, TWSP01, pp. 1012–1016.

Table 1. Summary of the accelerated beams in 2023.

Acceleration mode	Beam particle	Energy [MeV/nucleon]	Beam course	Beam intensity [particle nA]		Beam service time [h]		Availability [%]
				Requested	Actual	Requested	Actual	
RARF								
AVF-RRC	¹² C	135	E5A (Industry)	5	298.3	21.4	21.4	100.0
	¹² C	135	E5B (Biology)	5	298.3	24.1	16.5	68.5
	¹⁴ N	135	RRC Machine study	150	164.3	30.8	30.8	100.0
	⁴⁰ Ar	95	E5A (Industry)	1	68.2	140.6	140.6	100.0
	⁵⁶ Fe	90	E5B (Biology)	2	7.3	4.2	4.2	100.0
	⁸⁴ Kr	70	E3A (JAXA)	1	10.0	12.0	12.0	100.0
	⁸⁴ Kr	70	E5A (Industry)	1	13.1	204.4	204.4	100.0
	¹²⁹ Xe	35.58	E3A (JAXA)	1	1.1	11.9	11.9	100.0
	¹²⁹ Xe	35.58	E5A (Industry)	1	1.4	59.0	59.0	100.0
RILAC2-RRC	⁴ He	7.25	E3B (RI Production)	25000	55000.0	33.7	33.7	100.0
	⁵¹ V	6	E6 (KEK/MRTOF)	3000	2461.5	109.5	109.8	100.3
	¹²⁹ Xe	36	RRC Machine study	1	0.7	25.8	25.8	100.0
	¹³⁶ Xe	7.20	E6 (KEK/MRTOF)	100	120.0	36.0	36.0	100.0
	¹³⁶ Xe	10.75	E2B (KEK/KISS)	100	260.0	236.0	235.9	100.0
	¹³⁶ Xe	10.75	E3A (JAXA)	1	250.0	12.0	12.0	100.0
	¹³⁶ Xe	10.75	E6 (KEK/MRTOF)	100	160.6	36.0	36.0	100.0
	²³⁸ U	10.75	E5A (Material)	10	142.9	47.8	47.8	100.0
AVF-RRC-IRC	⁴⁰ Ar	160	E5B (Biology)	2	23.9	18.8	18.8	100.0
					Subtotal	1063.9	1056.6	99.3
RIBF								
Not performed due to trouble					Subtotal	0.0	0.0	-
					Total	1063.9	1056.6	99.3

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