OPERATION OF RILAC AT RIKEN

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Summary

The paper outlines the present status of the RILAC's increasing records on beam quality. Output currents and the number of ion species have been increased by the improvement of PIG source. Recently a pulsing of the RILAC beam has been tried using the rapid switching of the relative rf phase between accelerating tank 1 and tank 2.

Introduction

The RILAC started its operation in 1981 and has been used for studies in atomic collisions, solid state physics, and others. It will be also used as an injector for the Ring Cyclotron at RIKEN which is finishing a final assembly. Figure 1 shows the layout of the RILAC. It consists of a 500 kV electro-static injector and six accelerating tanks. A dotted line is the injection beam line for the Ring Cyclotron. Table 1 gives a specification of the RILAC. Figure 2 shows the relation between acceleration energies frequencies, and effective acceleration voltages.

Machine operation

The RILAC continues to deliver various kinds of ion beams for many fields of research. Table 2 gives statistics of operation in the period of July 14, 1985-July 13, 1986. The machine was operated five days a week except Saturday and Holiday. Figure 3 shows statistics of ion used. Most of users preferred Ar^{4+} ion, and 45 % of the total beam time was used for this ions.

Multicharged ions, C^{2+}, N^{3+}, Ne^{3+}, Ar^{4+}, Kr^{8+}, and Xe^{9+}, have been used. Ions of solid elements such as Mg^{3+}, Al^{3+}, Si^{3+}, Ti^{5+}, Cr^{5+}, Ni^{6+}, and Cu^{6+}, produced by a spattering PIG source, have also been accelerated and delivered into various target stations. A transmission efficiency of ion beam from ion source to the linac exit is 5 - 10 %. Table 3 gives the output currents of the RILAC ion source. The dashed line shows the lower limit of the charge to mass ratios which can be accelerated by the RILAC.

A pulsing of beam has been tried modulating the relative rf phase between accelerating tank 1 and tank 2. The pulsing of the beam in a time range longer than 1 msec has been successfully obtained. Figure 4 shows a pulsed beam obtained by the phase modulation of tank 2.

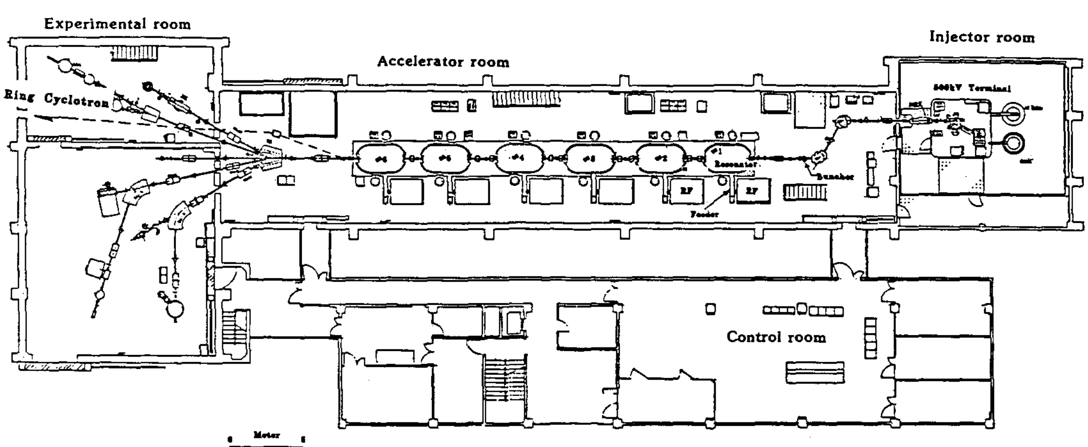

Fig.1. Layout of the RILAC

Table 1. Specification of the RILAC.

— SPECIFICATION —

Special Feature	Variable Frequency
Frequency Range	17~45 MHz
Charge to Mass Ratio	>1/27
Max. Energy	4 MeV/n for q/m=1/4 0.8 MeV/n for q/m=1/20
Mode of Operation	CW
Effective Acc. Voltage	16 MV (total)
Energy Tuning	Continuous
Injector Voltage	500 KV max
Ion Source	PIG
Accelerating Structure	Wideroe
Resonator	1/4λ coaxial
Number of Tanks	6
Drift Tube Aperture	20~30 mm
Field Gradient of Drift tube	6kG/cm(max)
Radial Phase Acceptance	200 mm-mrad
Operating Pressure	~10^7 Torr
Start of Operation	1981

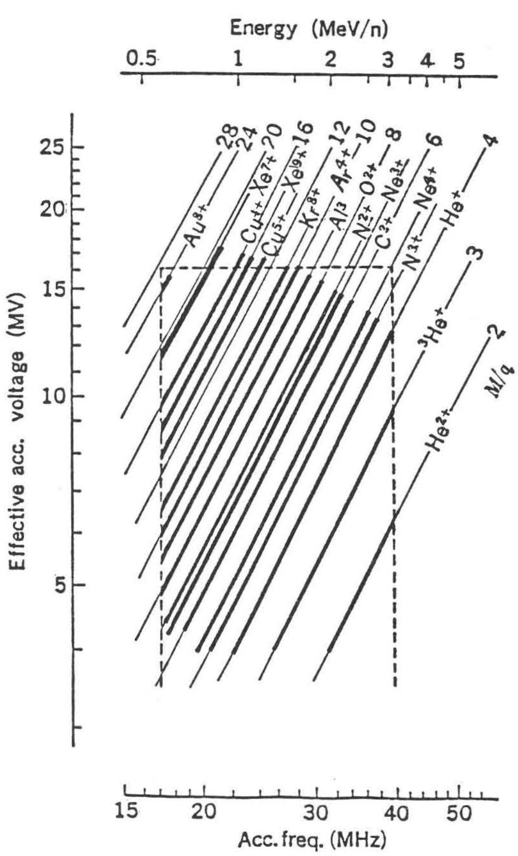

Fig. 2. Relation between energies, frequencies, and effective acceleration voltage.

Table 2. Statistics of operation in the period of July 14, 1985 - July 13, 1986

	Days	%
Beam time	182	49.9
Frequency change	19	5.2
Overhall and improvement work	36	9.9
Periodical inspection and repair	19	5.2
Scheduled shut down	109	29.8
	365	

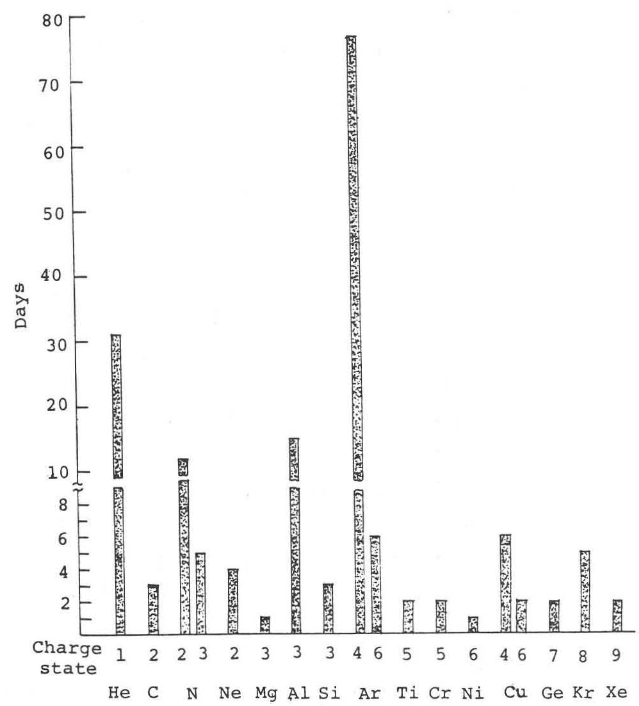

Fig.3. Statistics of used ions.

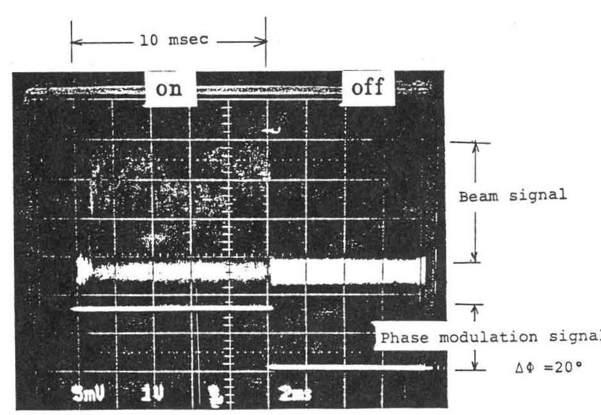

Fig.4. Photograph shows a pulsed beam obtained by the phase modulation of 10 msecond.

Table 3. The output currents of RILAC ion source.
Gases in the parenthesis are used to support the discharge. The dashed line shows the lower limit of the charge to mass ratios which can be accelerated by the RILAC.

		1+	2+	3+	4+	5+	6+	7+	8+	9+	10+	11+	12+	Sputtering materials
He		70	5											
C		24	100	–	o.6									
N		60	100	70	30	3								
Ne		40	80	52	5.2	0.2								
Ar		4.5	52	100	100	60	8	6						
Kr		1	13	48	52	64	58	23	5.8	0.4				
Xe		0.14	3.8	20	41	80	90	85	52	11	3	–	0.1	
Na	(Ar)	5.5	4.3	0.6										Nal crystal
	(Xe)	–	17	1.1	0.02									" "
Mg	(Ar)	4	23	5	0.25									Mg block
	(Xe)	–	60	7	0.2									" "
Al	(Ar)	13	–	70	–									Al block
	(Xe)	–	30	30	2.8									" "
Si	(Ar)	2.5	–	12	2.5									Si crystal
	(Xe)	–	8	7	1	0.02								" "
Ti	(Ar)	1	8	8	11	–	–							Ti block
	(Xe)	–	–	–	7	0.8	–							" "
Cr	(Ar)	1.2	9	15	–	–	2	0.1						Cr block
	(Xe)	1.5	–	–	27	11	1.4	0.03						" "
Fe	(Ar)	2	10	10	–	5.5	0.8	–						Fe block
	(Xe)	2.8	–	–	4.5	3	1.2	–						" "
Ni	(Ar)													Ni block
	(Xe)	–	–	–	–	1.8	0.3	0.02						" "
Cu	(Ar)	1	6	–	12	–	–	0.3						Cu block
	(Xe)	–	–	–	8.5	4	1.3	0.25						" "
Ge	(Ar)	–	–	0.9	2	6	6	5	2					Ge crystal
	(Xe)	–	–	–	–	–	–	0.05	0.07					" "