MULTIPLY CHARGED ION PRODUCTION BY THE RILAC PIG SOURCE

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1. Introduction

At the RILAC (RIKEN linac), ions of nine elements (C, N, O, Ne, Al, Ar, Cu, Kr, and Xe) have been successfully accelerated. The ions are produced with a side-extraction PIG source which is installed in the high voltage terminal (500 kV max.) of the injector.

2. Status of the RILAC PIG source

A schematic view of the source for metal ions is shown in Fig. 1 and main characteristics are listed in Table 1. The source is operated in the dc arc mode. Typical beam currents for each ion at the source and average source lives are listed in Table 2. In order to increase the higher charge-state components efficiently the pulsed mode operation of the source will be employed in near future. The Ar^{4+} beams have been accelerated most frequently beause of their long term stability and high beam intensity.

3. Beam identification method

The RILAC can accept a variety of ions (proton to U ions with a mass-to-charge ratio M/q smaller than 24). When multiply-charged ions are produced in the source, it is sometimes troublesome to search for the ions to be desired, because M/q spectra are complex at the source. In order to find the ion species, the beam identification method using charge exchange processes is employed at the beam analysing section of the RILAC injector (shown in Fig. 2). First the parameters of the injector system are set and optimized according to the acceleration conditions of the ions in concern. Next the vacuum in the beam duct between BM1 and BM2 is made bad up to $\sim 10^{-5}$ torr. While the field in BM2 is scanned the beam currents are measured with a Faraday cup FC013. The charge-exchanged components have peaks at $(q_i/q_f)\,I_o$, where q_i and q_f are the initial and final charge-states, and I_o is the optimized current of BM2. The example of the measurement for Ar^{5+} beam is shown in Fig. 3. The spectrum tells us that O^{2+} ions are mixed in the Ar^{5+} beam.

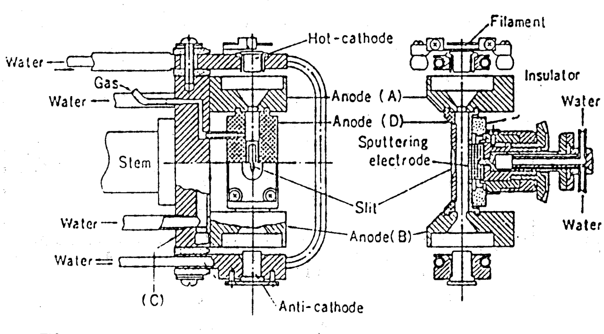

Fig. 1

Table 1 Main characteristics of the RILAC ion source

Magnetic gap	150 mm
Magnetic field	7.2 kG (max)
Distance between two cathodes	100 mm
Anode slit	1 x 20 mm^2
Puller slit	2 x 25 mm^2
Source-puller distance	3.5 mm
Limit vacuum pressure	7 x 10^{-7} torr

Table 2 Beam Intensity and Life

	Intensity(μA)	Life(hr.)
$^{12}C^{2+}$	7	
$^{14}N^{+}$	20	> 47
N^{2+}	2.2	
N^{3+}	2	
$^{16}O^{2+}$	10	
$^{20}Ne^{3+}$	1	
$^{27}Al^{2+}$	2.5	16
Al^{3+}	4	15
$^{40}Ar^{2+}$	30	
Ar^{3+}	50	33
Ar^{4+}	60	30
Ar^{5+}	10	
Ar^{6+}	2	
$^{63}Cu^{4+}$	8	> 8
Cu^{5+}	2.2	
Cu^{6+}	0.62	
$^{84}Kr^{5+}$	4	15.6
Kr^{6+}	0.55	4.6
$^{129}Xe^{7+}$	0.4	13.1
Xe^{8+}	0.1	

Fig. 2 The beam analysing section of the RILAC injector system

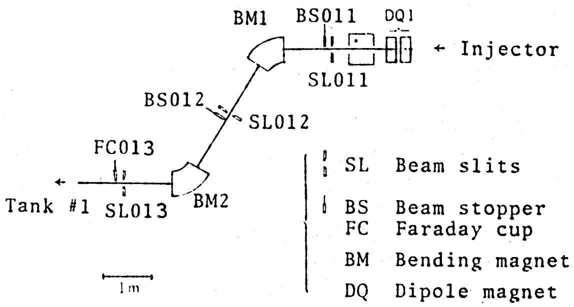

Fig 3 The beam currents at FC013 vs the magnet current of BM2. There are peaks due to single, double and triple electron capture processes of Ar^{5+} and to single electron capture and single electron stripping processes of O^{2+}.