Status Report on the Variable Frequency Heavy-Ion Linac, RILAC

M. Odera and RILAC group
Rikagaku Kenkyusho, Institute of Physical and Chemical Research

ABSTRACT

RILAC is a sole tunable linac in the world. High frequencies are used for light ions and low frequencies for heavy projectiles. It is being used for the various disciplines of IPCR. Its status of operation is described.

§1 Introduction

The variable frequency scheme of the RILAC has been introduced to facilitate focusing of the low velocity heavy projectiles having the very small charge to mass ratios. It also relaxes the requirement of the high accelerating gradient, hence the large power consumption for acceleration of the very heavy elements by the ordinary constant frequency linacs. By further keeping accelerating rate lower than that of the usual linacs, RILAC can be operated continuously.

This frequency variable, CW operation scheme is also a consequence of the design study of the Riken multi-statge heavy ion research facility project proposed in 1972[1)]. In that plan, a large separated sector cyclotron has been chosen as a post-stripper accelerator. In order to exploit capability of the cyclotron, the injector should be able to work in a CW regime and its accelerating frequency be tunable to the same or submultiple of the cyclotron RF, so that longidudinal phase matching of beams between the two accelerators can be made.

§2 Status of operation until July 1982

Figure 1 shows statistics of operation for the latest 6 months. Shaded area is the time used for researches and others for machine developments. Figure 2 gives ranges of frequencies and ions used in the same period. Time necessary to guide beams onto the targets varies considerably according to whether a good parameter set has been already accumulated or not in the

previous operation. For the time being, calculated values are used as a starting parameter set when the good reference does not exist. Optimization of the beam is then made manually.

Since by a relatively modest current, solid targets get easily burnt or melted owing to the large rate of energy loss of the low velocity heavy projectile, currents larger than 100 enA are hardly used except for gaseous targets. Therefore, life of the heavy ion source is moderate and is between 20 and 40 hours for Argon ion production. Details of the ion source operation are given in another paper[2].

Transmission efficiency of the beams through cavities is still improving in time. It is roughly 20 to 30 % for the first cavity and 5 to 10 % to reach the targets, through the six cavities and the beam transport pipings 15 to 20 meters long containing the quadrupole and dipole magnets. Scattering of the efficiency values depends on the ion species, vacuum condition and ion source characteristics.

Machine troubles experienced for the last half year are as follow: Vacuum leaks in the hard soldered junction of the cooling pipe inside of a cavity necessiated 20 days stop. Failutre of the insulators of the high power amplifier systems caused by water leakage from the cooling pipe of the vacuum tube made loss of 20 hours. There were troubles in the magnet power supplies, however, by quickly switching to the spare supplies, total time lost was less than an hour.

§3 Problems encountered in operation

As is well known in the heavy-ion linac technology, various unwanted ions having equal or nearly same charge to mass ratio with that of ions wanted are apt to be accelerated. Some means must be provided to discriminate those contaminant ions. The simplest is the measurement of the energy of ions by inserting a solid state detector directly into the beam path. Because outcoming ions from the linac have the same velocity or the same energy per nucleon, ions differing in mass have different total energies, which can be easily measured by this method. However, the solid detectors are rapidly destroyed by the heavy ion beam[3], unless special precautions are paid to attenuate intensity by a factor larger than 10^7.

Effect of the secondary electron emission also should be noted. Rate of emission from the surface of the diagnostic tools differs from ion to ion, energy to energy and depends on the geometrical configuration around the surface struck by the beam. Accurate measurement of the beam in the narrow space such as between cavities presents a problem. Other paper gives a case in which this phenomenon is used advantageously[3].

§4 Improvements planned in near future

An auto-tuning system is under preparation. It can set automatically various parameters of the whole amplifier system when the name of ions, energy per nucleon and number of cavities to be activated are givan by the operator. It includes tuning of cavities, scheme to pass the multi-pactoring region, keeping suitable amplitude and phase of the cavity field and curing program against vacuum sparking.

Pulsing circuit of PIG source is being prepared to get the higher charge state of the heavy elements than that obtained by DC operation. ECR-type ion source is also under development to get the higher charged ions and to increase the accelerated energy of the heavy elements. Decrease of the maintenance work of the ion source is also expected by that type[4].

References

1) M. Odera and T. Tonuma: Proc. 6th Intern. Cyclotron Conf., Vancouver 1972, p283, AIP Conf. Proceedings No.9, 1972

2) M. Kase et al: Performance of the PIG-type Ion Source, this Conf. 24-p-8.

3) M. Kase: Destructive Bunch Pick-up using Secondary Electron Emission and Capacitive Pick-ups for Beam Energy Determination by TOF, B-03.

4) M. Yanokura: ECR-type Heavy Ion Source, I-03.

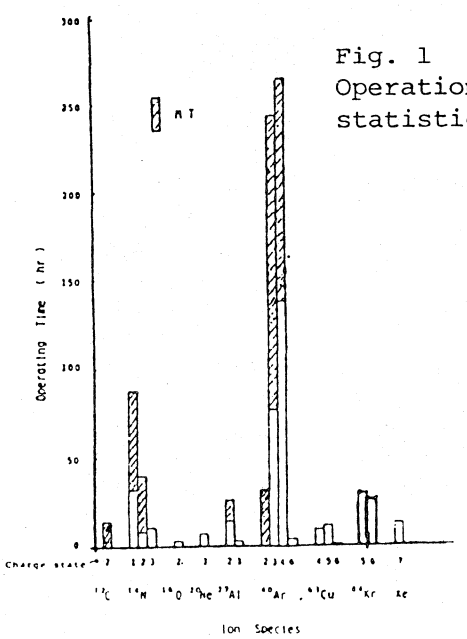

Fig. 1
Operation statistics

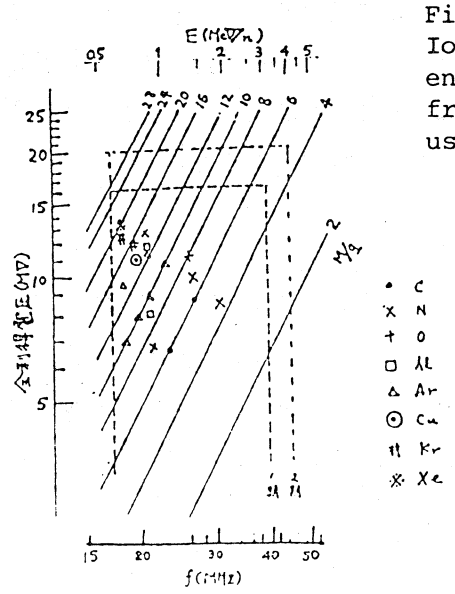

Fig. 2
Ion species, energies and frequencies used