THE ELECTRON BEAM ION SOURCE "KRION-C" PERFORMANCE ON THE LINAC LU-20 IN THE LHE

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Abstract

The disign of the Electron Beam Ion Source (EBIS) "KRION-C" and preliminary results on the ionization and acceleration of up to 5 Mev/u of sulpfure, argon and krypton ions by the LU-20 are presented. The cryogenic electron beam ionizer "KRION-C" was used as an ion sourse for the multicharged ions with mass - charge ratio band 0.35 - 0.5 at the accelerating facility of Laboratory of High Energies (LHE) in DUBNA.

Introduction

Work on accelerating heavier ions and nuclei is being continued at the accelerating facility of the LHE in accordance with a proposal on NUCLOTRON injector development. The "KRION-C" research program was begun in 1985 for the development of EBIS tecnology and experimental stydy of multicharged ionization processes for heavy ions. In 1988 we have realized for the first time electron beam with energies of 80 keV, an electron current of 0.2A and an electron density of 500 A/cm2. The confinement time for ions trapping into this electron beam was no more than 0.5 seconds. The ionization factor, namely, electron density times confinement time, was below 10^{21} cm-2. Now, the confinement time is a few seconds and an ionization factor is about $2 \cdot 10^{21}$ cm-2. This ionization factor is sufficient to produce bare argon and multicharged heavy ions wich have got ionization potensial about 4.2 kV.

Installation

The EBIS technology the ions to be produced are electrostaticaly trapped in the electron beam,radialy by the space charge of the electron beam, and exialy by the possitive potential to setting upon the first and final section of the drift tubes. The EBIS technology curcle begins with pulse injections of low charge ions into the ion trap. After that the trapping potential distribution is set up for some time, we named it's a "confinement time". When this time is over the positive barrier on the section of the drift tube is going down and the multicharged ions has been abandom ion trap through the extractor electrode.The principal of the design of "KRION-C" is shoun in fig.1. The Pierce electron gun with 1 mm diameter metallic-alloy cathode provides a 0.5A beam, at maximum, for the energy 10 keV. The electron beam is magneticaly compressed from the 0.15T cathode's field up to the 1.2T main magnetic field. This field has obtained by a small superconducting solenoid with 1.2 M length. The operation with 0.2A of the e-beam DC-mode is very stable. A high voltage potential (now, up to 40 kV) is supplied to the body of the installation. An electron gun and electron collector are inulated from the body with high voltage insulator. an electron beam 4÷10 kV from the is accelerated to it's finite energy passing through an accelerating gap located between an anode of the electron gun and a system of drift tubes. A similar gap decelerates the beam on the collector side.
The drift tubes stucture consists of

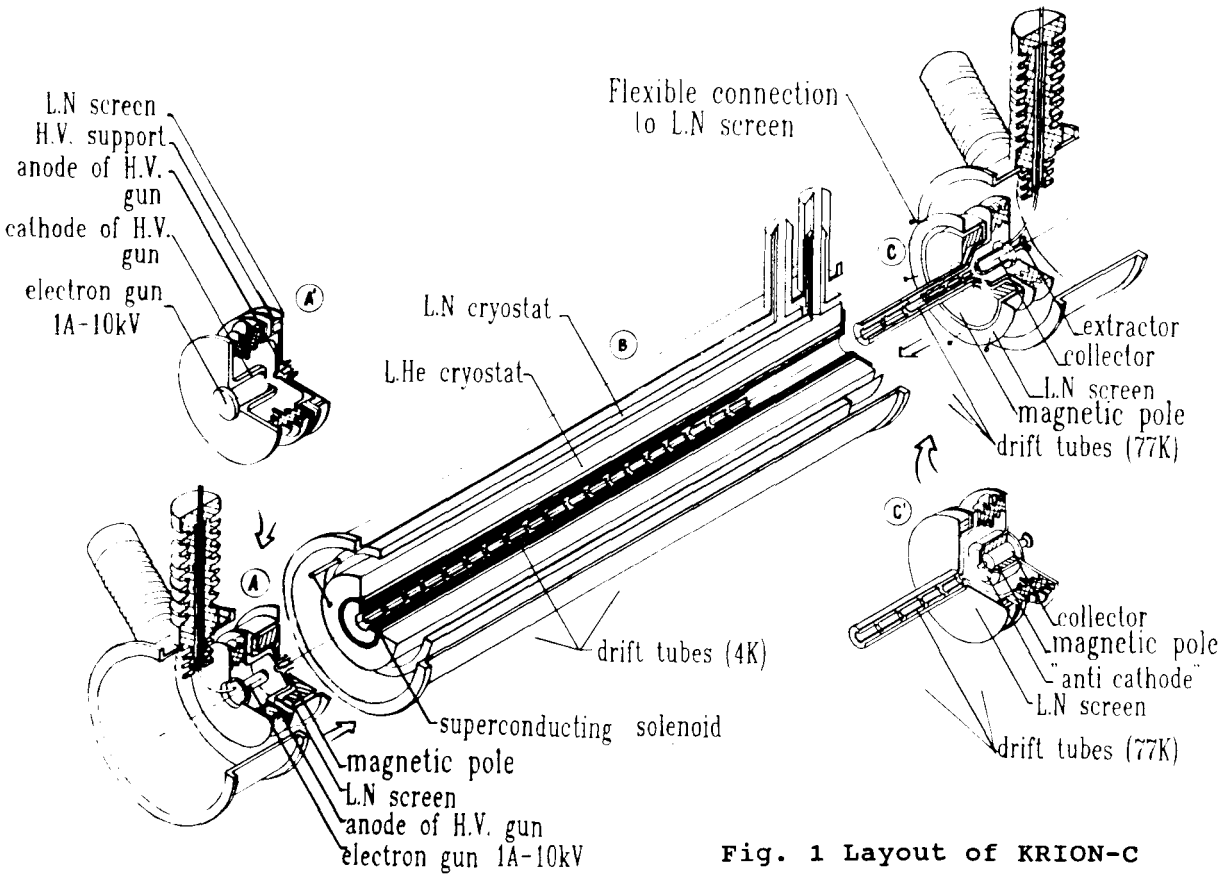

Fig. 1 Layout of KRION-C

the 25 drift tubes with different temperature, namely, 19 stanlysteel tubes at liquid helium temperature, 3 tubes at liquid nitrogen temperature and 3 tubes, whith wereat the room temperature. These latter tubes are constructed like a small furnace with a temperature of up to 300 C degree for avaporation of some solid state materials. The ier diameters for all drift tubes are 5 mm. Vacuum condition at the room temperature vacuum flange is better than 10^{-8} Tor,usially, with 65% of wather's vapor and 35% of carbon oxide, before ruing the e-beam. No more than 0.2% of hidrogen are found usially.The cryogenics system is cooling during those times. The liquid helium evaporation rate is approximately 0.28 l/hr, determined from the 180 l by normal gas.

"KRION-C" performance on the injector terminal.

The ionizer was installed on the HV terminal with pulse potentioal of about 500 kV for the injection into the RF linac LU-20M. The body of the source has been insulated from the

main HV platform on the potential about 40 kV. It means that we can produce e-beam with this energy on the HV terminal of linac. We have used fiber-optics links to control the "KRION-C". A plot of the experiment is shown in fig.2. The NUCLOTRON beam transport system, consisting of two bend magnets and stipper station, was as a magnetic specrtometer for multicharged acce-lerting ions. The ionization factor and some electron beam parameters were improved in comparison with the run of sulpfure acceleration [1]. A compensation degree of about 5% was conserved for a 0.25 A electron current and 7.5 keV energy electron beam for a three seconds of confi-nement time. It mean that an ioni-zation factor of about 2*1021 cm-2 has been obtained. The summary results are shown in Table 1.

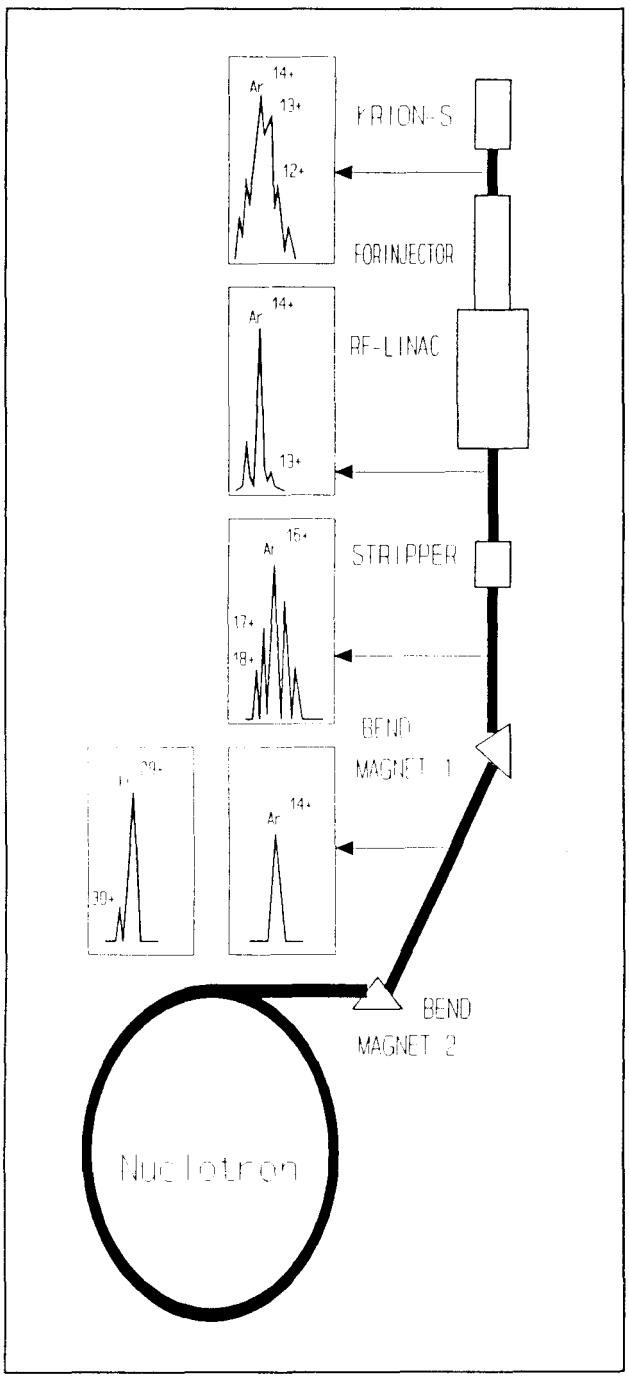

Fig. 2 Accelerating scheme

Table 1
KRION-C Performance

Laboratory parameters of the ion source	
1991	
Electron current	I_e = 0.5 A (DC - mode)
Energy of electrons	E_e = 60 keV
Ionozation factor	$j_t<1*10^{21}$ cm^{-2}
Runing parameters on LINAC terminal	Ions yield (charges per pulse)
1992	
I_e = 0.2A	S^{14+} - $5\cdot10^9$
E_e = 4.5 keV	
j_t = $2.5\cdot10^{20}$ cm^{-2}	
1993	
I_e = 0.25A	Ar^{14+} - $3\cdot10^9$
E_e = 6.5 keV	Ar^{15+} - $3\cdot10^9$
j_t = $1.2\cdot10^{21}$ cm^{-2}	Ar^{16+} - $1\cdot10^9$
	Ar^{17+} - $3\cdot10^8$
	Kr^{29+} - $2\cdot10^8$
	Kr^{30+} - $1\cdot10^8$
1994 (july)	
Ie = 0.3A	Kr^{29+} - $5\cdot10^8$
Ee = 7.5keV	Kr^{30+} - $5\cdot10^8$
jt = $2\cdot10^{21}$ cm^{-2}	Kr^{31+} - $4\cdot10^8$
	Kr^{32+} - $3\cdot10^8$
	Kr^{33+} - $2\cdot10^8$
	Kr^{34+} - $1\cdot10^8$

An energy of all accelerating ions is 5 Mev/u.

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References

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