LOW ENERGY CHANNEL FOR MODERNIZED LU-20

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Abstract

The modernization of LU-20 accelerator expects change existing electrostatic for-injector on RFQ type pre-accelerator. Low energy channel of transportation of beams is offered from three sources of ions: ESIS, LIS and SPIon - to RFQ. Parameters of channel and results of numerical modeling on fitting beams parameters with acceptance of RFQ are presented.

INTRODUCTION

The modernization of LU-20 accelerator expects change existing electrostatic for-injector on RFQ type pre-accelerator. Under this acceleration modes in the Alvarez linac must be preserved. Since at RFQ exit different energy of particles with Z/A =1 and Z/A ≤ 0.5 are required, it is expected use two separate RFQ. Modernization is conducted in 2 stages, first stage – RFQ for particles with 0.3 ≤ Z/A ≤ 0.5. A variant of low energy channel for beam transportation (LEBT) common for 3 ion sources: ESIS, LIS and SPIon – is offered.

ELEMENTS OF CHANNEL

Each source is situated on high-tension (before 150 kV) platform. The channel (Fig.1) begins from electrode with potential U0, after which a vacuum valve is fixed. In initial part of channel (IPC) the focusing electrodes with potentials U1 and U2 are located. IPC ends the tube with potential, falling off from U3 up to 0. Two solenoids, stated after initial part, form beams at the input of RFQ.

PARAMETERS OF BEAMS AND RFQ

Parameters of beams at the input in channel are given in Table 1, the input parameters of RFQ are specified in Table 2.

Table 1: Beam Parameters at IPC entrance

source, ions	Z/A	current mA	ε_n(4rms) π cm mrad	∅ beam mm	energy keV/Z
LIS, $^{27}Al^{+8}$	0.3	20	0.2	19	1
ESIS, $^{197}Au^{+60}$	0.3	10	0.15	10	19.7
SPIon, $^{2}D^{+}$	0.5	10	0.2	15	20

Table 2: RFQ Entrance Parameters

Z/A	I_{inj} mA	4rms $\varepsilon_{n\,x,y}$ π mm mrad	$\alpha_{x,y}$ rad	$\beta_{x,y}$ mm/mrad	U_{inj} kV
0.3	0	1.5	0.8818	0.0680	103
	10		0.9472	0.0721	
0.5	0	2.0	0.8818	0.0680	61.8
	20		0.9906	0.07545	

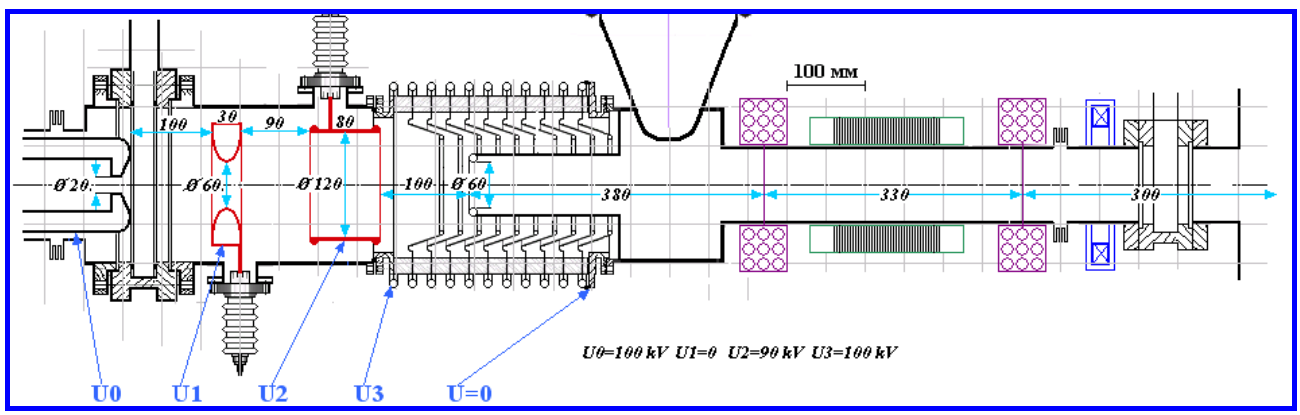

Figure 1: Schematic view of LEBT.

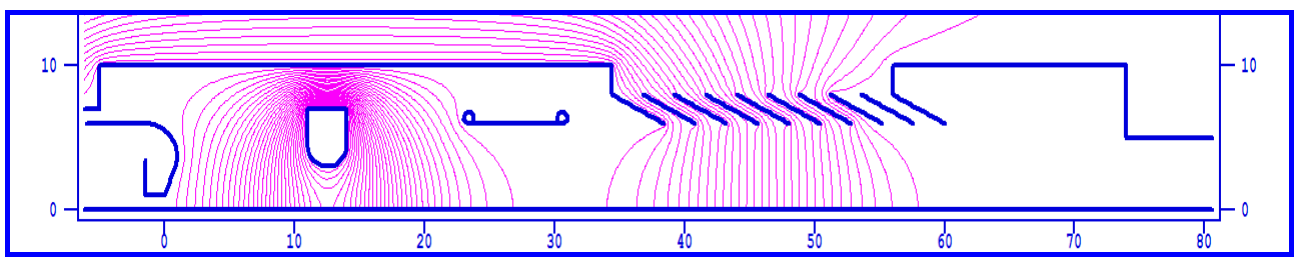

Figure 2: View of initial part of LEBT at POISSON code interface.

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RESULTS OF SIMULATION

Electrostatic field inside IPC and magnetic field of solenoids are calculated by the POISSON program [1]. Optimization of channel parameters to achieve required beam parameters at the RFQ entrance was performed by MCIB04 code [2].

View of initial part of LEBT and electrical field contours at POISSON code interface is shown in Fig. 2.

LIS, $^{27}Al^{+8}$, 20 mA

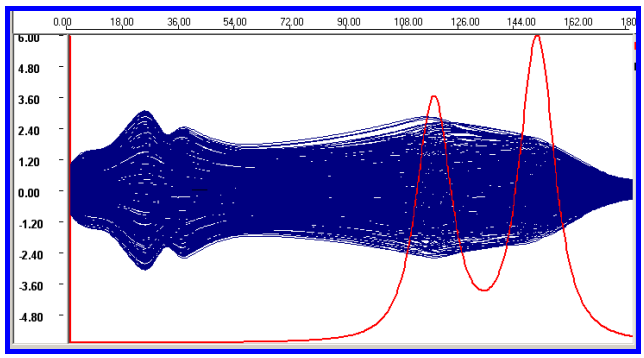

Figure 3: Ion trajectories and magnetic field.

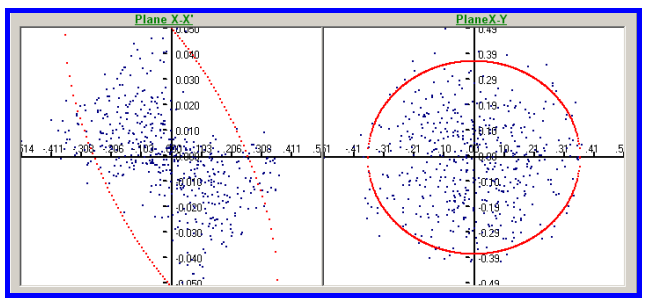

Figure 4: Phase plane and beam spot at RFQ entrance.

About 84% beam is in RFQ acceptance.

ESIS, $^{197}Au^{+60}$, 10 mA

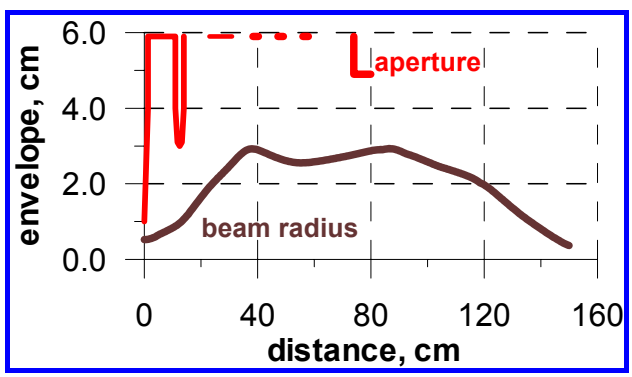

Figure 5: Beam envelope.

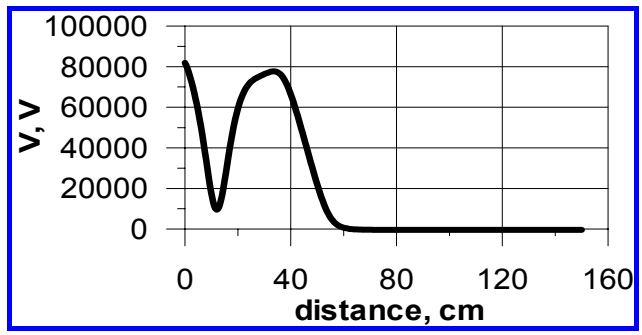

Figure 6: Potential distribution.

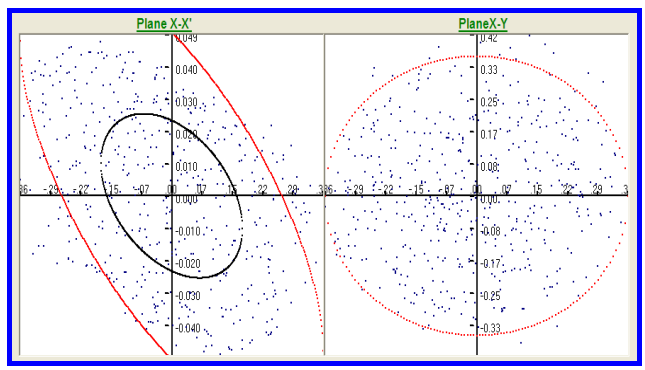

Figure 7: Phase plane and beam spot at RFQ entrance.

At RFQ entrance (z =150 см):
Emittance ε_n(4rms) = 1.3 π mm mrad,
Beam radius (2 rms) =3.4 mm,
$\alpha_{x,y}$ = 0.43 rad,
$\beta_{x,y} \cong 0.073 \div 0.074$ mm/mrad.

SPIon, $^{2}D^{+}$, 10 mA

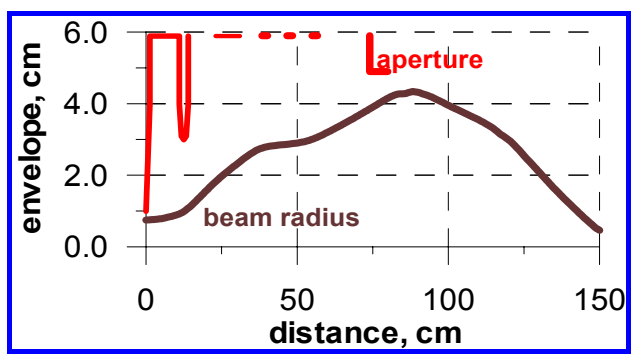

Figure 8: Beam envelope.

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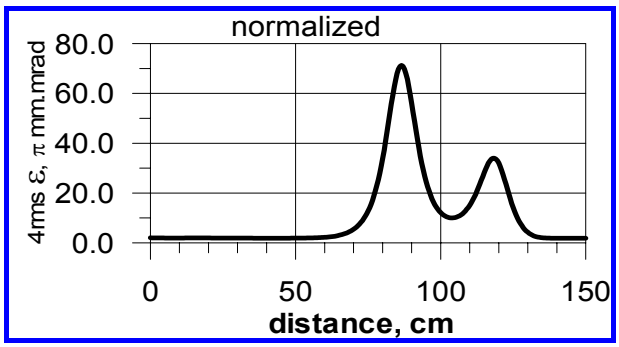

Figure 9: Normalized emittance.

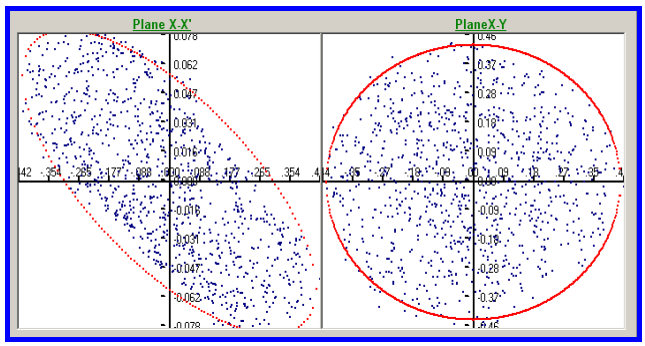

Figure 10: Phase plane and beam spot at RFQ entrance.

At RFQ entrance (z =150 см):
Emittance ε_n(4rms) = 1.84 π mm mrad,
Beam radius (2 rms) = 4 mm,
$\alpha_{x,y}$ = 0.98 rad,
$\beta_{x,y} \cong$ 0.0702 mm/mrad.

CONCLUSION

It was established that proposed variant of low energy channel is suitable for transportation of beams from three sources and injection of ions in to RFQ.
Channel length:
for SPIon and ESIS – 150 cm enough,
for LIS it needs not less than 180 cm to avoid too high fields in solenoids.

Channel Parameters For Different Ions

Deuterons, 10 mA
Potentials at energy 61.8 keV/Z:
U0=U2=U3=42.1 kV, U1=0.
Magnetic fields 4.63 and 4.38 kGs.

Gold, Z/A=0.3, 10 mA
Potentials at energy 103 keV/Z:
U0=U3= 84 kV, U2=75.6 kV, U0=0.
Magnetic fields 6.9 and 7.2 kGs.

Aluminum, Z/A=0.3, 20 mA
U0=U2=U3=100 kV, U1=0.
Magnetic fields 7.5 and 9.6 kGs.

REFERENCES

[1] F.C. Iselin and J. Niederer, The MAD Program, CERN/LEP-TH/88-38, Geneva, Switzerland, 1988.
[2] V. Aleksandrov, N. Kazarinov, V. Shevtsov, Multi-Component Ion Beam code–MCIB04, Proc. XIX Russian Particle Accelerator Conference (RuPAC-2004), Dubna, Russia, 2004, p.201.

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