STATUS OF THE SIBERIA-2 PREINJECTOR

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Abstract

The DAW structure linac-preinjector for the SIBERIA-2 SR complex had been commissioned at the end of 1992 when the 62.5 MeV electron beam was obtained. A 6-m-long high shunt impedance (95 MOhm/m) linac operates at 2.8 GHz. Now the linac injects the 75 MeV electron beam to SIBERIA-1 storage ring and work is underway to increase the beam current and energy. The experimental *RF* characteristics of the linac structure and beam measurements are reported, and the results of electron current, energy spectrum, beam profiles and emittance measurements are presented.

1 INTRODUCTION

The complex SIBERIA-2 developed in Budker Institute of Nuclear Physics (Novosibirsk) operates in Kurchatov Institute (Moscow) as a SR source [1]. It consists of a storage ring with 2.5 GeV maximum energy as the main part and a combination of a 80 MeV electron linac [2] and a 450 MeV booster ring SIBERIA-1 as an injection part.

This report is dedicated to the description of the 80 MeV linac shown in Fig.1.

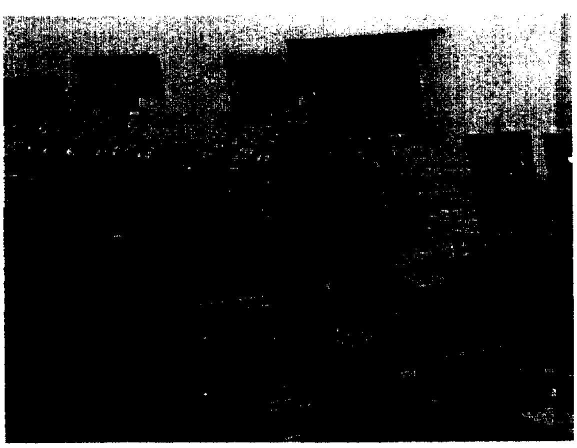

Fig. 1. The preinjector layout.

The booster ring SIBERIA-1 works in a single bunch mode with a revolution time of 29 ns. Therefore the linac current pulse duration are to be as large as 15–20 ns. The beam parameters required at the linac output are given in Table 1.

Table 1

Beam energy	80 MeV
Energy spread	1%
Beam current in a pulse	200 mA
Pulse duration	15 ns
Transverse emittance	0.1 mrad·cm
Repetition rate	1 pps

The linac operates in a stored energy mode.

2 LINAC — PREINJECTOR

The scheme of the linac is shown in Fig.2.

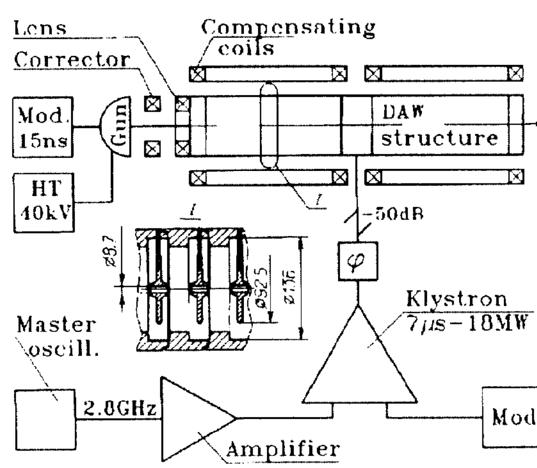

Fig. 2. The scheme of the linac.

The modification of the DAW structure [3] with radial stems [4] was selected as an accelerating structure of the linac. Each washer is supported by three radial stems, and the length of each close to $\lambda/4$. The use of the DAW structure in the stored energy mode enables us to solve the following problems:

- because of high shunt impedance one can reach maximum energy of electrons [5];
- because of a large energy stored one can accelerate the beam with maximum current;

- because of high group velocity there is a possibility to perform the accelerating structure in the form of a single resonance section with a single power input and thus to avoid phasing of separate sections and also to simplify the requirements for the accuracy of manufacturing and tuning.

Since we decided to use a single S-band 18 MW generator, therefore a 6-m-long DAW structure was selected to obtain the required energy of electrons.

The accelerating structure consists of six regular sections. Each section is brazed from cells. Sections are connected to one another through indium seals to provide vacuum and RF contact.

As a result of numerical and experimental researches, the optimal geometry of the DAW structure provided a very high shunt impedance of 95 MOhm/m and the absence of high order modes within ±20 MHz concerning operating mode like-TM0 2π was selected [6]. Dispersion curves of structure are given in Fig.3.

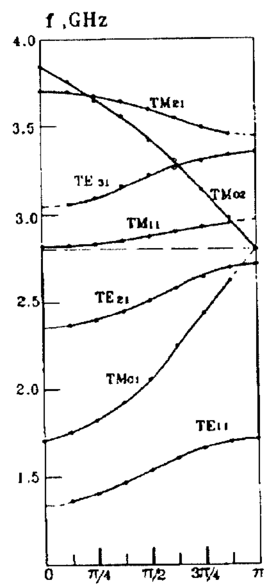

Fig. 3. Dispersion curves of structure.

The main characteristics of structure are presented in Table 2.

Table 2

Operating frequency	2797.2 ± 0.1 MHz
Effective shunt impedance	95 ± 3 MOhm/m
Quality factor	28000 ± 100
Characteristic impedance	3.4 ± 0.1 kOhm/m
Emax/Eacc ratio	5.5
Group velocity	0.4 c

The measured axial electric field distribution in the regular section is depicted in Fig.4.

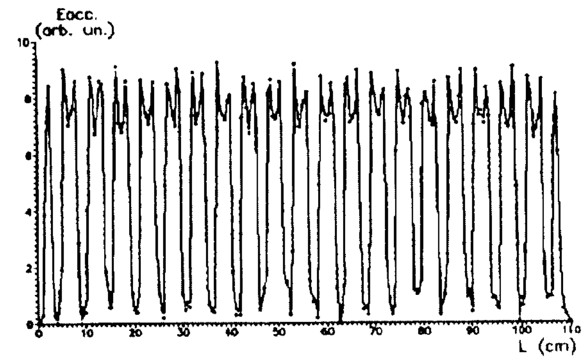

Fig. 4. The axial electric field distribution.

The structure is excited through the special coaxial cavity. It is installed in the middle of the structure and splits it into two equal parts. On this position of the exciting point of the structure the distance between the operating frequency and neigbouring frequencies is increased twice.

The 90×45 mm^2 waveguide consists of the vacuum and gas sections. The gas section is filled with nitrogen at about 6 atm. It is separated from the vacuum one by means of ceramic windows.

The experimental dependences of incident (Vinc.) and reflected (Vref.) wave amplitudes in the waveguide and voltage (Vlin.) on the linac versus the frequency of RF generator are given in Fig.5. As indicated in Fig.5, the waveguide length are to be equal to one of $(2n+1)\lambda/8$. Then the minimum overvoltage in the waveguide is provided in cases of detuning of the structure or breakdowns in it.

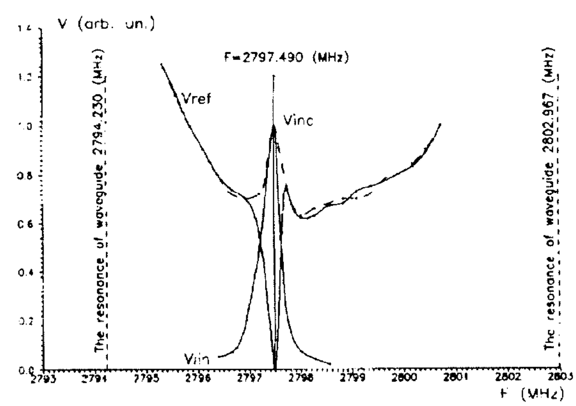

Fig. 5. RF signals.

The oscillograms of the RF signals (Vinc.—1, Vref.—2, Vlin.—3) are shown in Fig.6.

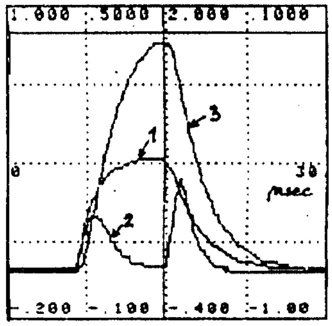

Fig. 6. The oscillograms of the RF signals.

The linac has a simple injection system without a special buncher (Fig.2) [6].

The nonbunched (40 keV, $4A$) beam formed by a diode gun is injected directly into the first cavity of the structure. Beam bunching takes place in the first cavity formed the regular halfcell.

The focusing system is also simple (Fig.2). Focusing is provided both by the matching lens in front of the structure and by an RF field of the structure. Also, to decrease the focusing RF field influence during beam passage we have to position a grid in the first cavity input hole. It enables us to decrease the beam emittance in the first cavity and to focus the beam without additional focusing elements in the accelerating structure.

3 BEAM EXPERIMENTS

The experimental energy spectra of the linac electron beam is shown in Fig.7 [7].

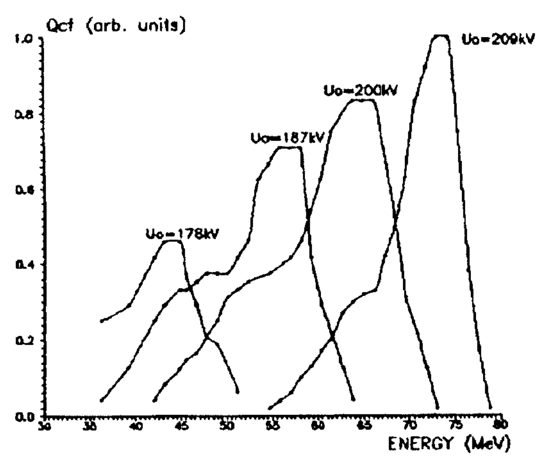

Fig. 7. The energy spectra of the linac beam.

The measured beam profile images are presented in Fig.8.

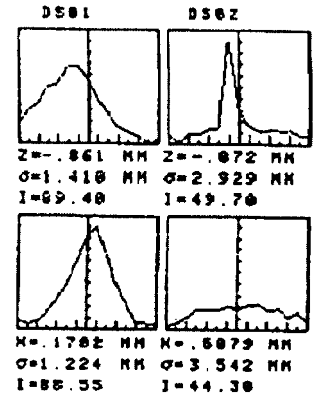

Fig. 8. The beam profile images.

The measured parameters of the electron beam at the exit of the linac are in Table 3.

Table 3

Maximum energy	75 MeV
Beam current in a pulse	
a) $\Delta E/E = 7\%$	600 mA
b) $\Delta E/E = 1\%$	65 mA
Pulse duration	18 ns
Transverse emittance	0.03 mrad·cm
Beam transverse size at 1600 mm apart from linac	3 mm
Repetition rate	1–5 pps

At the present time the linac injects the 75 MeV electron beam to SIBERIA-1 storage ring. The one-time capture current of the SIBERIA-1 is up to 23 mA at the equilibrium orbit.

4 CONCLUSIONS

The linac provides reliable operation of the SIBERIA-2 complex. Our experience in operating with the linac allows us to conclude that the designed 80 MeV electron beam can be obtained in the immediate future.

5 REFERENCES

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