

ELECTRON PREINJECTOR FOR SIBERIA-2 SR SOURCE

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Abstract

The 100 MeV linear accelerator operating in stored energy mode is described. It is designed to inject the electron beam (with 15 ns pulse duration and 200 mA current within 1% energy spread) into the booster ring.

The linac design is based on the 2.8 GHz DAW structure with three radial stems. The developed construction is easy for fabrication and tuning and provides a good shunt impedance of 92 MOhm/m and the working frequency domain being free of high order modes. The structure consists of a single 6 m long section.

The accelerator has a simple injection system without a special buncher. The nonbunched 40 keV beam formed by a diode gun is injected directly into the first DAW cavity.

The focusing system is simple too. It is provided both by the matching lens in front of the structure and by an RF field and has no focusing elements in the acceleration channel.

The first results of the accelerator performance are presented.

INTRODUCTION

The complex «Siberia-2», which will be built in Moscow [1] will serve to use as a SR source. It will

fronts on the beam dynamics. The beam parameters required on the injector output are given in Tabl. 1.

Table 1

Beam energy	80 – 100 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 modification of the DAW structure [2] with radial stems [3] was selected as an accelerating structure of the preinjector. Each washer is supported by three radial stems, which have the length close to $\lambda/4$. The use of DAW structure at the stored energy mode enables one to solve the following problems:

- because of high shunt impedance one can reach maximum energy of electrons [4];
- 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 an 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 to accuracy of manufacturing and tuning.

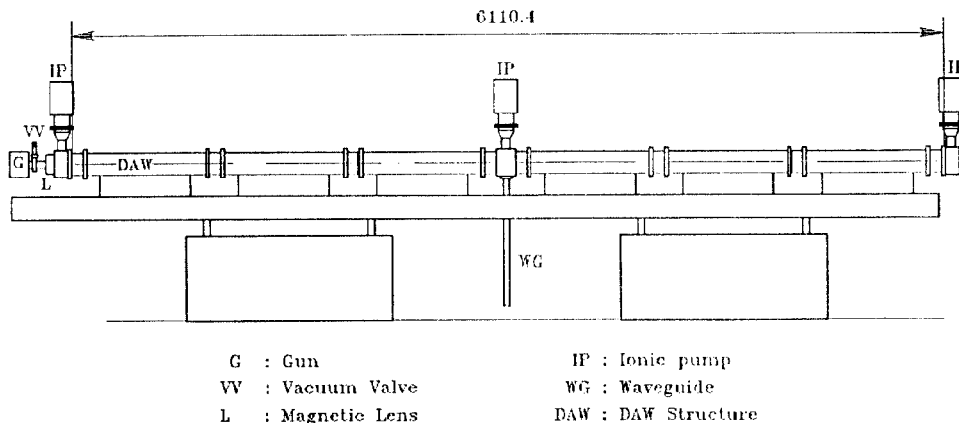


Fig. 1. The preinjector layout.

consist of a storage ring with 2.5 GeV maximum energy as the main part and a combination of a 100 MeV electron linac and a 450 MeV booster ring «Siberia-1» as an injection part.

This report is dedicated to description of the 100 MeV linac-preinjector shown in Fig. 1.

OPERATING MODE

The booster ring «Siberia-1» will work at a single bunch mode with revolution time of 30 ns. Therefore the injector current pulse duration should not exceed 15 ns in order to avoid the influence of the injector

BEAM DYNAMICS

The accelerator has a single injection system without a special buncher (Fig. 2). The same injection system had been developed for the linac-positrons source of the complex VEPP-4 [5].

The nonbunched 40 keV beam formed by a diode gun is injected directly into the first resonator of the structure. The diode gun is shown in Fig. 3. The LaB₆ spherical cathode has diameter of 16.4 mm. The gun forms the parallel electron beam with the current of 4 A and with the diameter of 8 mm directly after the anode hole.

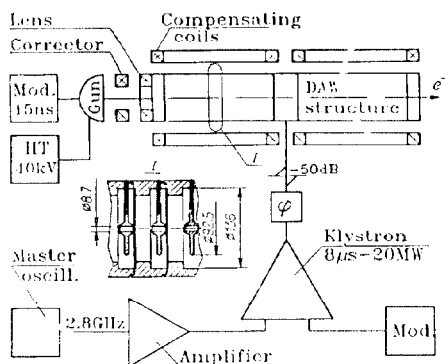


Fig. 2. The beam forming system and RF system.

A beam bunching is realized in the first resonator, which consists of the regular halfsell with the plate front wall. The calculated beam spectrum at the accele-

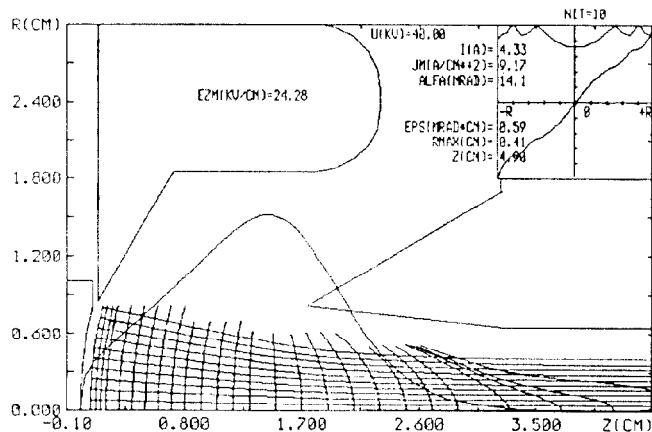


Fig. 3. The diode gun layout with beam trajectories.

rator output is shown in Fig. 4. From this figure one can see, that the beam spectrum density change at the

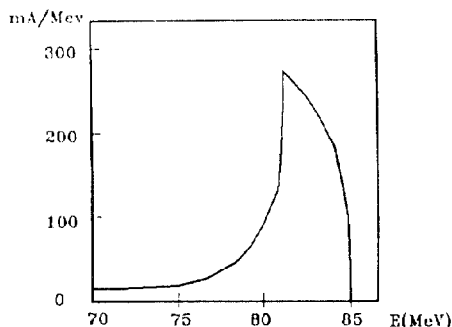


Fig. 4. The beam energy spectrum in the preinjector output.

electron energy about 80 MeV is little, within of 5% relative energy range. Because of this, one can provide the stable injection current under an unstable RF voltage.

The focusing system is simple too (Fig. 2). It is provided both by the matching lens in front of the structure and by an RF field of the first resonator. Also for a decrease in the focusing RF field influence under beam flying one must set a net in the first resonator input. It is provided essentially to decrease the beam emittance in the first resonator output and to do without additional focusing elements in the accelerating channel. Also in the beam travelling system there are a corrector for parallel shift and coils for compensating the Earth magnetic field.

The calculations by means of computer code based on the macro particle model show, that the beam emittance in the accelerator output will not exceed of $5 \cdot 10^{-2}$ mrad·cm, and the beam radius will not exceed more of 60% of the aperture.

RF SYSTEM

The preinjector RF system is shown in Fig. 2. It consists of the generator connected to accelerating structure by means of 90×45 mm² vacuumable rectangular waveguide. Power input is in the middle of the structure. Since we concentrated on use of the only one

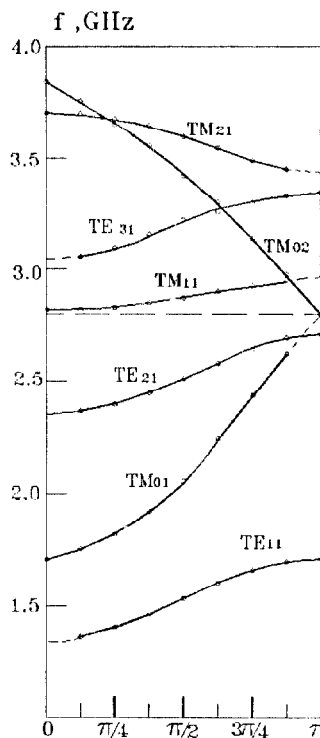


Fig. 5. The DAW structure modes spectrum.

S-band generator of 20 MW power [6] therefore the full length of the DAW structure was selected of 6 m.

As a result of numerical and experimental research [7] the optimal geometry of DAW structure provided a good shunt impedance of 92 MOhm/m and absence of high order modes within ± 20 MHz concerning working mode like $-TM_{02\pi}$ was selected. The dispersion curves of the structure are given in Fig. 5.

The thermal test of the 1 m long section of structure showed that the temperature gradient of the frequency change is of 50 kHz/deg C°.

The 0.6 m long section of structure has been tested at high power [8]. The stable voltage pulse was received in 8 hours of

training by means of multipacting and breaks in the leading edge. The field level received on surface of structure corresponds to accelerating gradient of 15 MeV/m.

The DAW structure parameters are given in Tabl. 2.

Table 2

Frequency,	f_{exp}	2795.7 MHz
Eff. charact. res.,	ρ	3.4 kOhm/m
Quality factor,	Q_{exp}	27 000
Overvoltage coef.,	k_0	4.0
Rel. group velocity,	β_g	0.4
Length,	L	6.1 m

CURRENT STATUS

At that time all preinjector systems had been mounted into the complex «Siberia-2» accelerating hall. The measurements of the DAW structure at low power level had been made. The shunt impedance experimental value is of 92 MOhm/m. The accelerating structure had been matched with the waveguide. In the accelerating structure and waveguide had been received vacuum.

The electron gun feed system and klystron master oscillator had been tested. At present, the preinjector is ready for operation.

CONCLUSION

From the description given above one can single out the following points of interest:

— the use of the DAW structure allowed to design the compact preinjector more efficient compared to the traditional linacs based on the disk-loaded waveguides. For example, the 100 MeV preinjector of the SR source described in report [9] requires the generator with close to twice as much power at the same full length and the more complicated prebunching system.

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