ELECTRON LINEAR ACCELERATOR OF VEPP-5 PREINJECTOR

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Abstract

The main purpose of injector complex VEPP-5 is to produce the intense electron and positron bunches of high quality for Budker INP e+e- collideres. Injector includes two S-band (2856 MHz) linacs [1] and 500 MeV damping ring. The paper gives an overview of the electron linac. Electron beam measurements are presented also.

INTRODUCTION

The electron linac is designed to provide intense electron beams of short length as required for positron production. The main parameters are listed in Table 1.

Table 1: The main parameters of electron linac.

Output energy	275 MeV
No. of electrons per bunch	$1.8 \cdot 10^{10}$
Electron beam emittance	$7 \cdot 10^{-5}$ cm·rad
Maximum repetition rate	50 Hz
RF frequency	2856 MHz

ELECTRON LINAC

The linac consists of an electron gun, subharmonic buncher, S-band buncher, five accelerating sections, focusing system and a system of beam diagnostics (see Fig. 1).

An electron beam generated by the electron gun has the following parameters: 200 kV energy, 4 A current, and 3.5 ns width.

A single bunch mode of linac operation is a basic one for injection in damping ring. The time-of-flight buncher system is installed downstream the electron source in order to achieve a single bunch regime of operation. The system includes two cavities operating at the 16^{th} RF subharmonic (178.5 MHz), RF buncher operating at the main accelerator frequency (2856 MHz) and first accelerating structure. The bunch compression line is located inside solenoid.

The accelerating structures of VEPP-5 pre-injector are round disk-loaded waveguides of constant impedance.

SLED system is used to increase the accelerating gradient up to 20 MeV/m. The RF pulse length is 3 μs from SLAC klystron 5045 type. The filling time of the structure is 0.5 μs. Every klystron feeds up 3 accelerating structures. In order to increase beam current accelerating gradient in first accelerating structure is 25 MeV/m.

EXPERIMENTS

Linac beam diagnostic system includes wall current monitor, magnetic spectrometer, sets of secondary-emission sensors, phosphor and Faraday cup installed before conversion target (see Fig. 1).

Beam parameters after electron gun is measured by wall current monitor. The results are 4.2 A current and 3.5 ns impulse duration. Beam charge is calculated as integral if monitor current. Thus number of beam particles after electron gun is $(5.5 \pm 0.1) \cdot 10^{10}$

Beam energy at the end of linac is calculated from magnetic field value in first bending magnet. The phosphor screen installed after bending magnet displays beam position with 1.5 % error. Thus the beam energy is determined with 1.5% error.

Emittance measurements are carried out by set of 3 secondary emission sensors. The measurement method is considered in [2]. Secondary-emission sensor consists of fifteen vertical wires and fifteen horizontal wires. Distance between wires is 1mm. Wire thickness is 50 μm. Example of beam size measurements is shown on fig. 2. Volumes of beam radius are 1.7 mm in horizontal and 2.3 mm in vertical. Beam size is considered as half width of Gaussian distribution approximation. It was established that the main source of emittance error is beam size measurement error. For our case relative error of

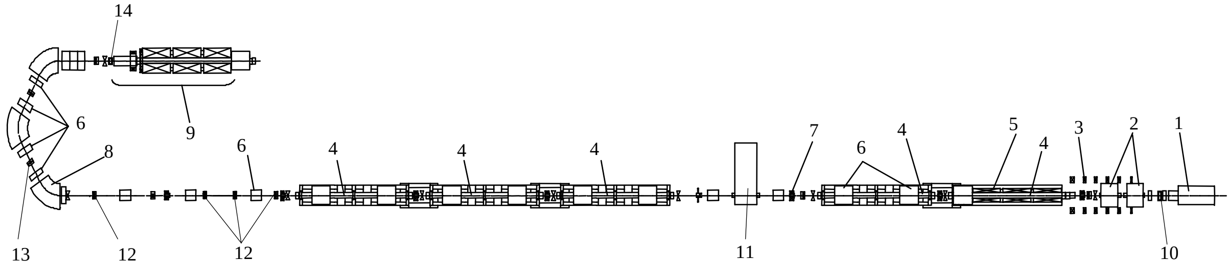

Figure 1: Lay-out of electron linac, isochronous turn and conversion system of injector complex VEPP-5. 1 — electron gun, 2 — subgarmonic buncher, 3 — focusing coil, 4 — accelerating structure, 5 — solenoid, 6 — quadrupol lens , 7 — corrector, 8 — banding magnet, 9— conversion system and first positron structure, 10 — wall current monitor, 11 — spectrometer, 12 — secondary-emission sensor, 13 — phosphor screen, 14 — Faraday cup.

emittance is about 25%. The result of beam emittance measurement is $(0.8\pm0.2)\cdot10^{-4}$ cm·rad.

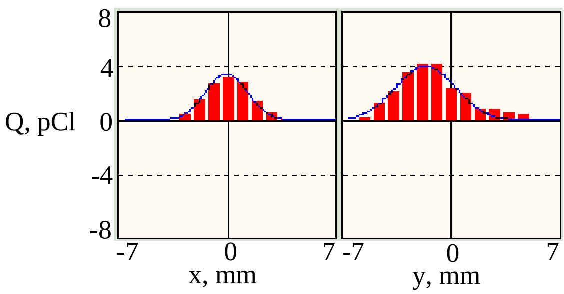

Figure 2: Beam profile monitor measurement results x and y - beam dimensions, Q – measured wire charge for histogram. curve – approximated Gaussian distribution.

The measurements of electron beam current after isochronous turn were carried out by Faraday cup. The shape of signal is shown on fig.3. In order to decrease secondary electron emission +300 V was fed on faraday cup.

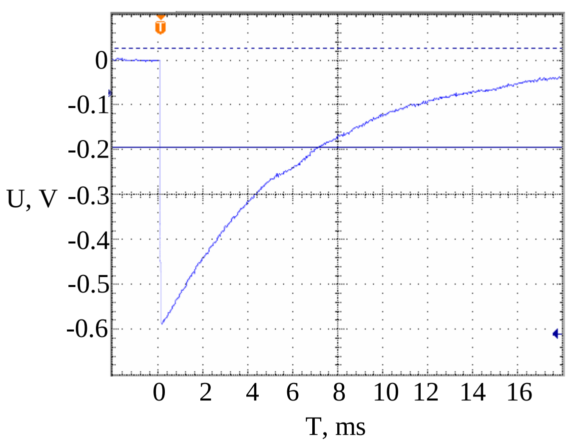

Figure 3: Faraday cup discharge signal. U – Faraday cup voltage, T - time.

Electromagnetic shower in Faraday cup was simulated by Geant4 [3]. Simulation shows that yield of charge from Faraday cup is less then 5%. So the relative measurement error is 5%. The result is $(1.8\pm0.1)\cdot10^{10}$ electrons per pulse.

CONCLUSION

The bunch current in accelerating structure is limited by wake fields. Beam current limit is about 1 kA for linac[1].

To increase electron current a new electron gun is planed to be installed. The gun current is projected about 10 A. To improve charge characteristic in first part the beam passing planed to be optimize.

REFERENCES

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[3] S. Agostinelli et al. “A Simulation Toolkit”, Nuclear Instruments and Methods A 506 (2003) 250-303.