STATUS OF THE LINEAR ACCELERATOR-INJECTOR AT THE TNK FACILITY

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In 2006, the work was continued at the linear accelerator-injector of TNK facility, Zelenograd. In November-December, the linear accelerator conditioning was carried out to increase the output electron energy. The accelerated electron beam was obtained at the Faraday's cup located in the plane which was equivalent to the booster ring entrance point. The paper presents the accelerating structure conditioning results and diagrams of the beam pulse shape at the accelerator output and energy spectrum at the booster ring input.

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In 2006, the work was continued at the linear accelerator-injector of TNK facility, Zelenograd [1], for the following purposes:

- conditioning of the linear accelerator to enhance the electron beam energy up to 70 MeV;
- transportation of the accelerated electron beam to the Faraday cup placed in the plane symmetrical to the booster ring entrance;
- stabilization of "Olivin" modulator pulse amplitudes and continuous adjustment of the KIU-43 anode voltage from 170 kV up to 230 kV (in collaboration with modulator developers, "RIPR", St. Peterburg);
- installation of the linac gun vacuum and cooling protection operated in automatic mode;
- development and installation of the temperature stabilization system for the linear accelerator.

Fig.1 presents the TNK facility accelerator scheme. "Olivin" klystron station with KIU-53 klystron is used as an RF power source. RF power of about 16 MW must be transferred through the waveguide section into the accelerating structure to obtain 70 MeV electrons at the accelerator output [2].

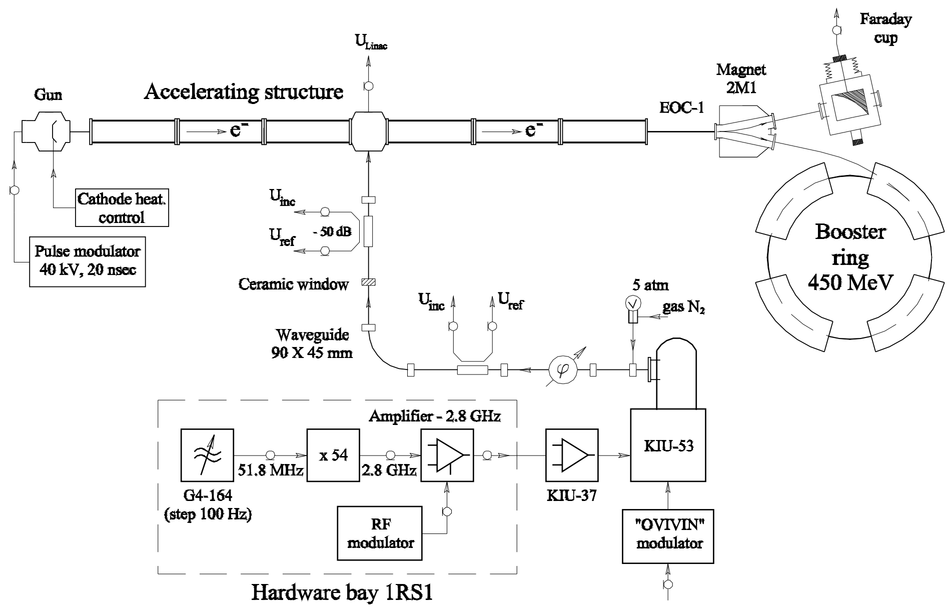

Fig.1. TNK accelerator facility

After two weeks of conditioning, the stable RF field in the acceleration structure was obtained at the level sufficient for the required electron energy at the linac output. The level and stability of the linac accelerating field was controlled with U_{lu} signal from the center cavity of the accelerating structure (see Fig.1) [3].

The current was measured with the current monitor placed directly at the linac output (Fig.2) and the Faraday cup after the turning magnet (Fig.3). Optimization was carried out by the use of correctors and focusing lenses in the structure and EOC-1 channel.

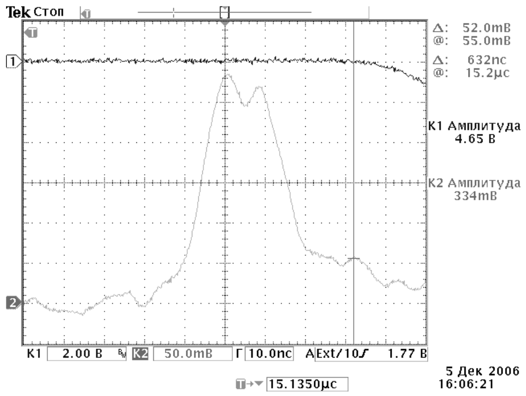

Fig.2. Accelerated beam current shape at the linac output (K2)

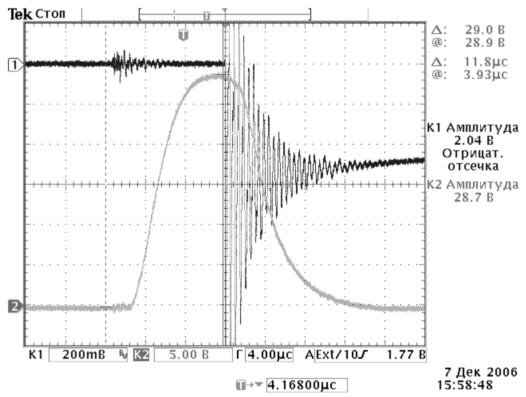

Fig.3. Faraday cup (K1) and accelerating structure (K2) voltages

Turning magnet 2M1 together with the Faraday cup were used for electron energy measuring. Fig.4 presents the experimental curve of the Faraday cup voltage versus the 2M1 magnet current. Measurements was carried out in 2005 [4] and after accelerating structure conditioning in 2006. The measured energy of the accelerated electrons was about 70 MeV at the 2M1 magnet current of 11.5 A.

The accelerating structure resonant frequency drifts with temperature changing by the rate of 50 kHz/°C. The structure frequency stabilization is carried out by the water heated by induction heater and supplied through six copper pipes, soldered to the outer surface along the section.

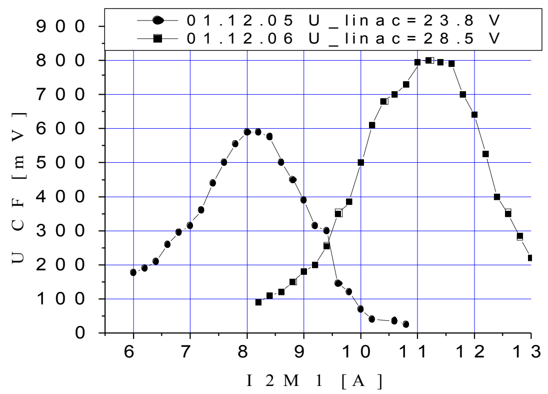

Fig.4. Faraday cup voltage versus 2M1 magnet current

Temperature stabilization system for the linear accelerator is shown in Fig.5. Each W_H coil is connected to the resonant circuit L_R, C_R. The power is controlled by varying the frequency of inverters (which is always higher than the resonant frequency) within the range of 20…40 kHz.

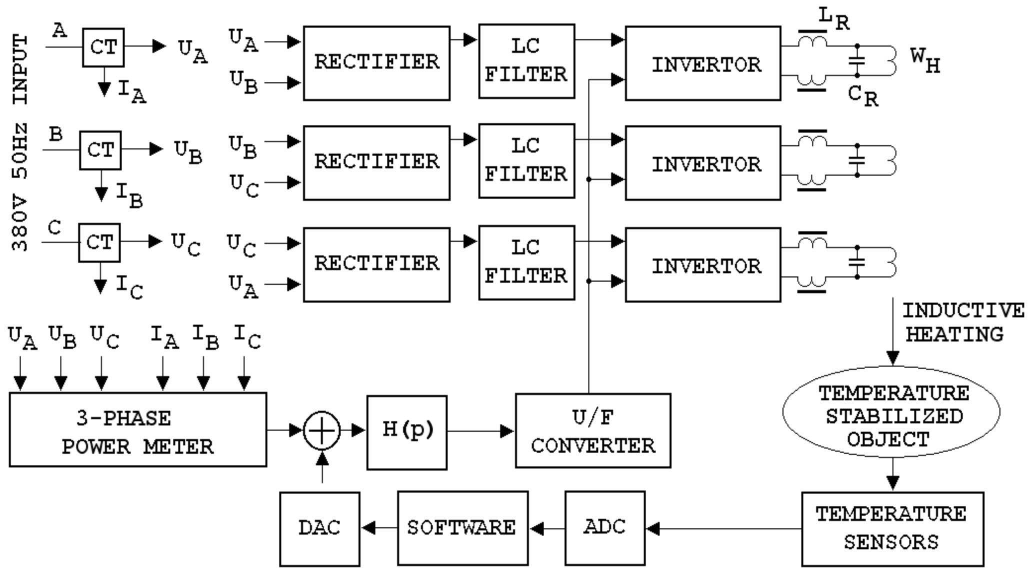

Fig.5.Temperature stabilization system for the linear accelerator

The system has two control loops. The first one stabilizes by hardware the power consumed from three-phase electric network according to the reference signal from ADC. This circuit contains H(p) unit which provides the needed adjustment quality, voltage-to-frequency converter, inverters with filters and rectifiers, and meter of the power consumed. The second circuit is abridged through the computer and uses software which defines the law of control. The second circuit consists of the controlled object proper, temperature probes, ADC, and DAC.

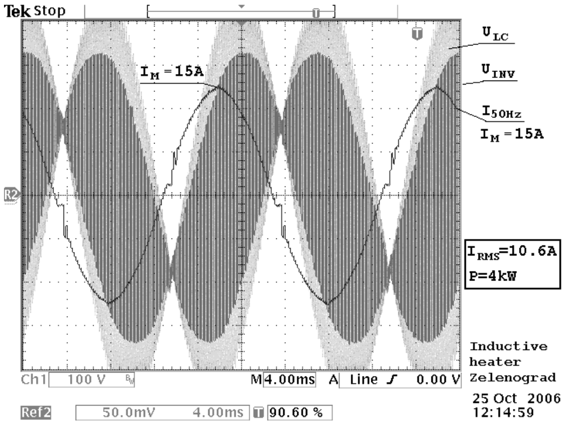

Fig.6. Oscillograms of the consumption current (I_{50Hz}), inverter output voltage (U_{INV}), and resonant circuit voltage (U_{LC})

Inverters are fed by the rectified interphase voltage of 540 V amplitude at 100% ripple level, because the LC filter capacitance is minimal. As a result, the consumed current shape from each network phase is close to sinusoidal. The power factor is about 1. Oscillograms of the consumed current, output inverter voltage, and resonant circuit voltage are shown in Fig.6.

One of three units was assembled and tested. Maximal system power is 30 kW, temperature stabilization quality is about 0.1 K.

CONCLUSION

As a result of the work carried out, all the accelerator systems operate safely and provide the electron beam with the energy of about 70 MeV. The further energy growth is possible at continuous accelerator operation.

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СТАТУС ЛИНЕЙНОГО УСКОРИТЕЛЯ-ИНЖЕКТОРА КОМПЛЕКСА ТНК

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В 2006 г. были продолжены работы на линейном ускорителе-инжекторе комплекса ТНК г. Зеленоград. В ноябре-декабре была проведена тренировка линейного ускорителя с целью повышения энергии электронного пучка на выходе ЛУ, а также получен ускоренный электронный пучок на цилиндре Фарадея, который находится в плоскости, эквивалентной входу пучка в малый накопитель. Представлены результаты тренировки ускоряющей структуры, а также графики формы импульса тока пучка на выходе ЛУ и энергетического спектра пучка на входе в малый накопитель.

СТАТУС ЛІНІЙНОГО ПРИСКОРЮВАЧА-ІНЖЕКТОРА КОМПЛЕКСУ ТНК

О.В. Анчугов, К.Н. Чернов, А.В. Філіпченко, Б.А. Гудков, Є.Н. Кокін, Н.В. Матяш, А.С. Медведко, Г.Н. Острейко, С.І. Рувинський, Г.В. Сердобінцев, В.А. Ушаков, Н.Н. Грачов, В.П. Храмцов, Н.В. Спинко, А.М. Долгов, О.Є. Кільдишева, В.Н. Корчуганов, Ю.В. Крилов, Д.Г. Одинцов, А.Г. Валентинов, Ю.Л. Юпінов

В 2006 р. були продовжені роботи на лінійному прискорювачі-інжекторі комплексу ТНК м. Зеленоград. У листопаді-грудні було проведене тренування лінійного прискорювача з метою підвищення енергії електронного пучку на виході ЛП, а також був отриманий прискорений електронний пучок на циліндрі Фарадея, що перебуває в площині, еквівалентній входу пучка в малий накопичувач. Представлено результати тренування прискорювальної структури, а також графіки форми імпульсу струму пучка на виході ЛП і енергетичного спектру пучка на вході в малий накопичувач.