CONTROL SYSTEM OF ELECTRON LINAC LU-40

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The reconstruction of a two-section electron LU-40 linac was finished in 2004. The accelerator consists of two accelerating sections and an injector, the latter includes a diode electron gun, a klystron type buncher and an accelerating cavity. Pulse current at the accelerator exit is up to 200 μA, the beam energy is up to 100 MeV.

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1. CONTROL SYSTEM STRUCTURE

A special system (Fig.1) has been developed for linac control. It controls an electron beam current, energy and position, defends accelerating and scanning systems from damage caused by the beam; blocks the modulator and the klystron amplifier in the case of intolerable operation regimes; regulates phase and power of HF signals in the injecting system and also regulates the source power currents in the magnetic system. The program & technical complex consists of a PC equipped with fast four channels ADC into the CAMAC crate (Fig.1), a synchronization unit, microprocessor-operated complexes to monitor the thermostatic system (ADAM-5511) and magnet current sources (MP-1816). The software of IMS operates under Windows environment and was written with the use of a visual object-oriented programming system C++Builder 5.
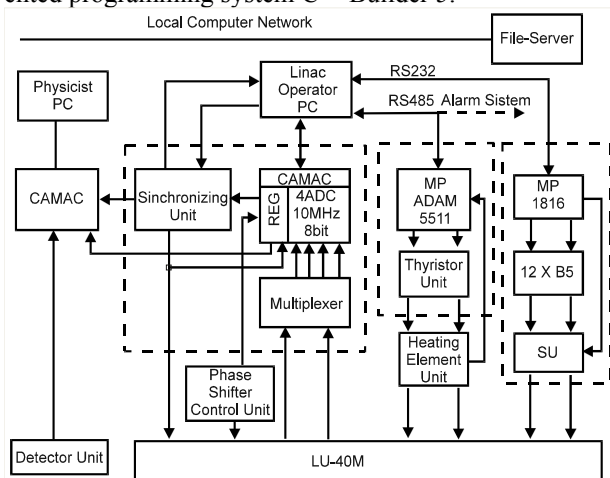

Fig.1. Control system functional diagram of the LU-40 accelerator

The multiplexer (MP) and the analogue to digital converters (ADC) with 8 digits receive a signal from analog pulse sensors with 50 or 100 nsec discreteness by 4 (out of 32) switching channels simultaneously. The information about linac system state and beam parameters is shown on the local unit terminals (CP) and on a color graphics display (Fig.2). The operator can monitor the linac work from the PC keyboard and from the local control panels. The program units can provide the momentary or repeated control over system parameters or give operating commands. Simultaneously, the parameters of several systems can be controlled and only one of them can be regulated at a time.
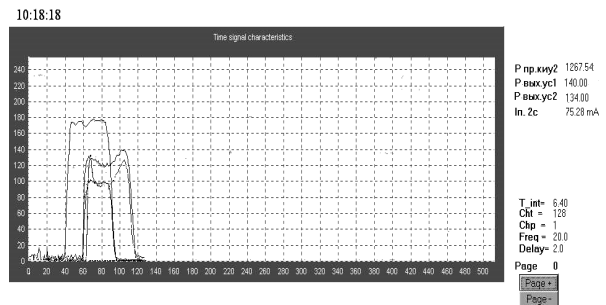

Fig.2. Tuning videogram of accelerator LU-40

Data for parameter beam accelerator transmit to the information system for the physicists and transmit to computer network of the scientific research complex "Accelerator".

2. OPERATIVE CONTROL OVER CURRENT AND POSITION OF AN ELECTRON BEAM

The linac is equipped with magnetoinductance transducers placed at the input and output of accelerating structures for measurement of a value and form of beam pulse current [2]. The signals from transducers are used in the control system for rating the amplitude and average current values (Fig.2). The sensors calibration is carried out periodically with the test pulse trains from a special current generator [3]. The linac exit is also equipped with four winding position sensors [3]. These sensors register the beam center position with *0.5 mm* error [4]. The magnetic analyzer is used for electron energy control [1].

3. SYNCHRONIZING SYSTEM

A synchronizing system of the LU-40 accelerator forms the frequency scale of pedestal pulses $f_0 = 100, 25, 12.5, 6.25, 3.125$ or *1 Hz*. The operation startup frequency of EGM modulator and KPA modulator are f_0. KPA modulator starts twice if $f_0 = 12.5, 6.25 3.125$ or *1 Hz*. The synchronizing unit has *10* channels. Pulse amplitude is not more than *15 V*, the pulse width is 2.5 ± 0.5 *μs*, the delay range is from *0 to 10 μs* with the step *0.1 μs*. When the alarm signal "Beam switching off" is received from accelerator systems, the electron beam is turned off with additional delay of EGM startup pulses on *11 μs*. There are continuous synchronizing system mode and mode of the pulse dosage. Required pulse number from 1 to 9999 is specified by an operator. Pulses with frequency f_0 are synchronous with a frequency of supply line (50 ± 0.5 *Hz*).

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4. THERMOSTATIC SYSTEM

A thermostatic system of the LU-40 accelerator provides thermal stabilization of two accelerating sections and the accelerating resonator. The system consists of *7* temperature-sensitive elements, *3* transducers of water flow through the objects being cooled and a detector of water level in the tank. The thermostatic system ADAM 5511 consistent with a personal computer (PC) is used for analysis of signals from the transducers.

Information on controlled object state is transferred to the controlling PC via RS-485 interface; the lock signals come to an alarm system.

5. ALARM SYSTEM

The alarm system monitors more than *50* discrete state signals of the accelerator systems. It allows turning on the high voltage of supply for the injector (HV) and two modulators. If equipment malfunction occurs, a command is received to execute an emergency shutdown of the HV and beam current. The local control is conducted from the klystron room while remote control is performed from the main control panel. Information on system state is presented on the local control panel [6].

6. MAGNET POWER SUPPLY CONTROL

Twelve direct current sources B5-47 and B5-49 are used for current traction of the magnet accelerator elements. The controlled relay switching unit (SU) was designed to reverse the source polarity. There exists a possibility to change the source current and polarity either manually or automatically. In the latter case after the PC command obtaining, the microprocessor (MP 1816) sets the polarity and current values of the sources. A message is sent to the LU-40 operator if instant values differ from specified ones.

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АВТОМАТИЗИРОВАННАЯ СИСТЕМА КОНТРОЛЯ И УПРАВЛЕНИЯ УСКОРИТЕЛЯ ЛУ-40

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В 2004 году закончена реконструкция двухсекционного линейного ускорителя электронов ЛУ-40. Ускоритель состоит из двух ускоряющих секций и инжектора, который включает в себя диодную электронную пушку, группирователь и ускоряющий резонатор. Импульсный ток на выходе ускорителя до 200 мА, энергия пучка до 100 МэВ.

АВТОМАТИЗОВАНА СИСТЕМА КОНТРОЛЮ ТА КЕРУВАННЯ ПРИСКОРЮВАЧА ЛП-40

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У 2004 році закінчено реконструкцію двохсекційного лінійного прискорювача електронів ЛП-40. Прискорювач складається з двох прискорюючих секцій та інжектора, який включає до себе діодну електронну гармату, групoвач і прискорюючий резонатор. Імпульсний струм на виході прискорювача досягає 200 мА, енергія пучка − 100 МеВ.

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