PHYSICAL STARTING OF THE FIRST AND SECOND SECTION OF ACCELERATOR LINAK-800

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Abstract

The report discusses the modernization of the linear electron accelerator MEA (Medium Energy Accelerator). The aim is to develop a set of MEA based free-electron lasers, imposed a number of emission wavelengths from infrared to ultraviolet. In work presents the results of the physical starting of the first accelerating station and status of work on the second accelerating station linear electron accelerator LINAC-800, as well as start the infrared undulator. We discuss the program of work of the accelerator.

INTRODUCTION

JINR accelerator creates a stand based on electron linear accelerator LINAC-800. The linear accelerator LINAC-800 energy of 800 MeV and a pulse current up to 60 mA and a duration of 4 microseconds modernized to create a complex free-electron lasers, covering a continuous spectrum from infrared to ultraviolet. Currently launched the first accelerating section of the accelerator and the undulator infrared radiation. Preparing to launch a second accelerating station. Installed the klystron second accelerating station. Obtained by working vacuum in the waveguide path and accelerator sections.

LINEAR ELECTRON ACCELERATOR

Structural linear accelerator consists of the electronic injector and seven accelerator stations - part of LINAC-800. Linac accelerating system is 4 accelerating station (A00 - A3), including sources of RF power (klystrons with modulators), microwave - feeders and accelerating structures (panels + drift sections). Injection station A00 consists of a the gun and the buncher. Accelerating station A01 provides the short accelerating section A0BB (length 3.67 m) and the drift area DS0 / 1, combined with a portion of the analysis of the characteristics of beam (energy, current, size, position, emittance). Microwave power to the accelerating section A01 station is served by accelerating station A00. Accelerating station A02 enables two short accelerating sections A1AA and B2AA to 3.67 m with a longitudinal magnetic field and the portion of the drift DS2 / 3. Regular accelerating station A02 and A03 provide job length (7.35 m) accelerating sections (two sections of the station). The stations are separated by drift spaces (DS2 / 3 - DS4 / 5) with a length of 1.5 m. Section, composed of one station are separated by nearly identical portions of the drift (DS3 / 4 - DS5 / 6). At sites drift installed vacuum locks, vacuum pumping stations, quadrupoles, correctors beam position, current monitors, beam position and profile.

The structure of the electron injector includes an electron gun, a chopper, and prebuncher and buncher (Fig. 1).

Figure 1: The electron injector.

Its main element is a triode type the electron gun with a permanent high voltage at the cathode, "grounded" the anode and the gate electrode [1]. It is placed in a tank filled with sulfur hexafluoride (SF6) under pressure about 6 atmospheres. Electron-optical system of the gun control electrode formed by and a system of 15 the anodes with forced resistive (R = 200 MW) distribution of the potential (of the order of 30 kV on the gap). At first focusing the anode supplied with a DC voltage, adjustable between 12 - 30 kV. The source ICT (Insulating Core Transformer) provides a cathode voltage -400 kV with the stability of 10-4 - 10 -5 [2]. The source is placed in the tank with the insulating gas under a pressure of about 6 atm. The stability of high voltage with an additional unit "ICT 400 kV Stabilizer". Voltage is applied to the high-voltage oil-filled the gun in a coaxial cable with a diameter of 6 cm at a pressure of 2-3 bar oil. Cable core - bifilyar on which the tank to the console electronics with high voltage power is supplied to the cathode electronics unit 110 B, f = (U 50 Hz).

THE KLYSTRON MODULATOR

The modulator linear type consists of a pulse transformer and 40 the block pulse shapers. Each of these blocks is performed by a printed circuit and able to generate a pulse amplitude of 2 kV duration of 50 microseconds. The magnetic core of the pulse transformer is made up of several cores, each of which has a coil connected to two blocks of the pulse generator. In the secondary winding of the transformer pulses are summed. In this scheme, the

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amplitude and pulse repetition rate varies depending on the number of blocks included formers.

Figure 2: The klystron and PFN-cabinet.

Mode of operation of the modulator as a part of the accelerator stand JINR different from its mode of NIKHEF [3]. The modulator has been designed for operation in high (up to 2.5 kHz) pulse repetition frequency. In this case, it was possible to quickly change not only the pulse repetition rate, but also the power of a video at the modulator output. It was necessary to quickly change the number of PFN-modules to one of the summing transformer winding, the number of affected transformer windings, provide alternate modes of the modules when the pulse repetition frequency was less time to charge the storage line module, change the frequency of the pulse start and distribute them to the modules. Also, the introduction of the scheme required a shunt (unused in a particular pulse) summation transformer winding. This required to enter to control the starting PFN-modules so-called "DSP." The processor can randomly distribute the modules in a loop starting from 256 pulses. The repetition rate of 10 Hz cycles. Hence frequency "grid" pulses 2.56 kHz or 390.6 ms. Consequently, the possible pulse repetition frequency modulator range from10 Hz to 2.56 kHz. Requirements for the modulator at the moment (the frequency is 1-10 Hz pulse repetition rate with a fixed output power) allow you to completely obviate the need to apply the "DSP". Need to constantly connect the required number of modules (30) and tap the desired number of windings of the summing transformer (15) with a fixed ratio (1:11). Unused windings must be short-circuited, eliminating bypass circuit windings. Technical Analysis available PFN-modules showed that the proposed simplification is already partially implemented in NIKHEF. In PFN-module is not all circuits and components associated with the launch of the channel, "1:11", and a real choice of windings "1:8" or "1:11" was carried out by physically connecting the correct cable from the connector to the channel "1:8". Possibility of rejection of "DSP" is particularly relevant on the basis of the fact that he designed over 30 years ago, the current technical condition of unknown communication protocols nowhere described. It is easier to design and build from scratch, rather than run, especially since there is not any software. Instead of "DSP" was developed by a simple asynchronous trigger system modulator with pulse decoupling driver for each module. Subsequently, when the number of modulators and accelerator sections, if necessary synchronization of these sections may construct digital timer system [4]. Figure 2 illustrates the klystron in the tank a high-voltage pulse transformer the modulator.

PHYSICAL STARTING OF THE FIRST ACCELERATING SECTION

After the commissioning of on the modernized modulator first accelerating station klystron was train in the diode mode to full-anode voltage and current. Was received the RF power and began training the first accelerating section. This work continued for several months. After reaching the desired level of the field in the accelerating section was carried acceleration electron beam [5].

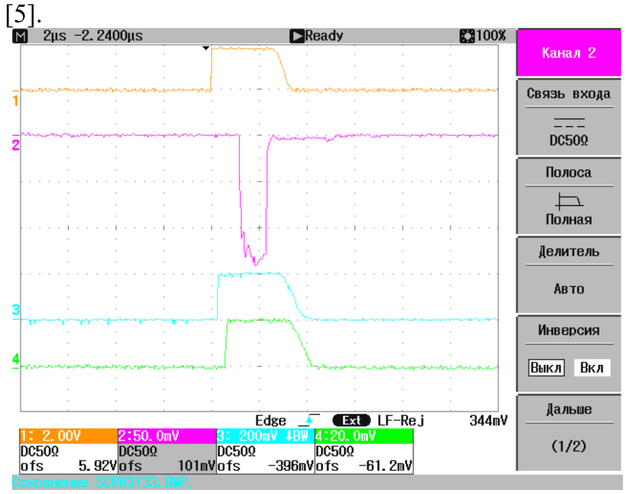

Figure 3: Oscillograms of the beam current (2) and the envelope of the field in the accelerating section and buncher.

The output current of the accelerating section of the induction sensor and the measured Faraday (Fig. 3) cup energy through 45-degree bending magnet. Electron beam with a current of 5 mA was accelerated to an energy of 20 MeV. Further work continued to increase in the current and began assembling the undulator infrared. After installation of the undulator (Fig. 4) the accelerated electron beam was conducted through an undulator and outlet undulator registered the infrared radiation with a wavelength of 14

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microns. Studies over the undulator radiation were stopped in order to continue the work on the second accelerator station. Was upgraded modulator the klystron second accelerating station mounted klystron and the waveguide system. Obtained working vacuum in the accelerating sections and waveguide tract (Fig. 5). Are currently under commissioning in the second accelerator station.

Figure 4: Configuring the undulator.

Figure 5: The bending magnet, undulator, drift gap and the accelerating section of the second accelerator station.

CONCLUSION

Launched the first the accelerating station. Obtained the accelerated electron beam with an energy of 20 MeV and current up to 10 mA. The undulator Installed IR range and from the obtained IR radiation with the wavelength 14 microns. Conducted commissioning of the second accelerating station. By the end of the year will be accelerated beam of electrons to an energy of 70 MeV.

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