MAGNETIC BUNCHER ACCELERATOR UELV-10-10-T-1 FOR STUDYING FLUORESCENCE AND RADIATION-PHYSICAL RESEARCHES

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Abstract

Accelerator UELV-10-10-T-1 is equipped with special system of injection and magnetic buncher with the purpose of generation picoseconds the beam duration 50 ps with the current 150 A at energy 10 MeV for studying fluorescence and radiation-physical researches. For maintenance of the magnetic bunching the accelerator works in the mode of the reserved energy when duration of the pulse of injection (2,5 nanoseconds) is much less than time of filling of a wave guide energy (100 nanoseconds). At a pulse microwave of capacity 10 MW the energy which has been saved up in the wave guide, makes about 2 J. It provides an opportunity of a cutting collimator separately chosen bunch after scan of "package" by a rotary magnet. After an output from the accelerator the package electrons from 3-5 bunches acts in magnetic buncher consisting of two electromagnets. In buncher the beam is scanning as "fan", and then focused. At a current of the beam 30 A in the pulse duration 2,5 nanoseconds distinction on energy between the adjacent bunches makes of 300 keV, that provides an opportunity of the cutting collimator the separate chosen bunch after space scanning with a rotary magnet. At a magnetic bunching electrons in "head" of a bunch have the big energy and are transported on trajectories with the big radius than "tail" electrons. Thus "compression" of the bunch on time is attained and accordingly the charge of a bunch increases.

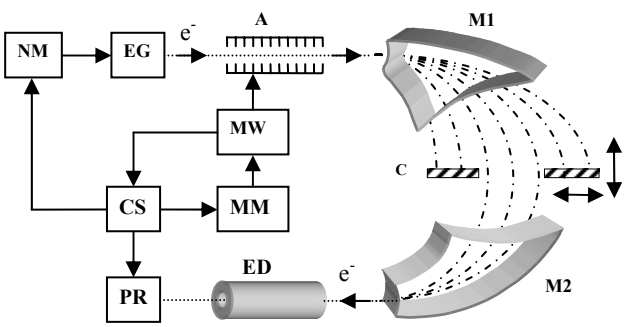

Fig. 1: A function chart of system of formation picoseconds pulses on accelerator UELV-10-10-T-1. NM - nanosecond modulator; EG - an electronic gun; A - the accelerator; M1 - a rejecting magnet; M2 - a focusing magnet; C - collimator; ED - the electro-optical detector of parameters of the beam; PR the pulse registrar; CS - the circuit of synchronization; MM - the modulator magnetron; MW - magnetron.

Accelerator UELV-10-10-T-1 is equipped with special system of injection and magnetic buncher with the purpose of generation picoseconds beam for studying fluorescence and radiation-physical researches [1-7]. The basic connections between the equipment of system of formation of accelerator UELV-10-10-T-1 are submitted on a function chart (see Fig. 1).

MAGNETIC BUNCHER TECHNOLOGY

Appearance of system of formation is shown in Fig. 2. The principle of action of system of formation is based on features of work of the accelerator electrons in a mode of use of the reserved energy. In such accelerator at sufficient loading the current arises significant reduction of energy electrons between the next bunchs, as is used for allocation of a separate clot from an initial pulse with the help of a dividing electromagnet.

Duration of bunch makes approximately 0,1 periods of the microwave of fluctuations of the generator of the accelerator (~ 50 ps).

Fig. 2: Appearance of system of formation picoseconds pulses on accelerator UELV-10-10-T-1.

For maintenance of a magnetic grouping the accelerator works in a mode of the reserved energy when duration of a pulse of injection (2,5 ns) is much less than time of filling of a wave guide energy (100 ns). At pulse power of the microwave 10 MW the energy which has been saved up in a wave guide, made about 2 J. At a pulse current more than 10 A distinction energy the next clots makes about 200 keV. It provides an opportunity of a cutting collimator separately chosen clot after scanning of "package" by a rotary magnet. After an output from the accelerator the bunch electrons as a package from 3-5 clots acts in magnetic buncher consisting of two electromagnets. In buncher the beam is scanning as "fan", and then focused.

Magnetron with capacity 10 MW in a pulse allow "to reserve" in the wave guide energy up to 2 J and to spend her for small time of injection electrons (2,5 ns) in

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comparison in time filling of the wave guide (100 ns) is insignificant. In a case when the pulse of injection (1,5 ns) is much less than time of filling of a wave guide microwave power (~ 100 ns) the accelerating field essentially varies at passage of clots through a wave guide (see Fig. 3). The first clots will select more energy, than the subsequent, that leads to broadening power spectrum of the beam.

Effect broadening a spectrum usually various methods try to minimize. In our case, on the contrary, it is necessary "to widen" the spectrum to simplify a problem of allocation of one bunch. At big enough current of a beam (30 A) in an initial pulse duration of 2,5 ns the difference energy the next clots is equal 300 keV.

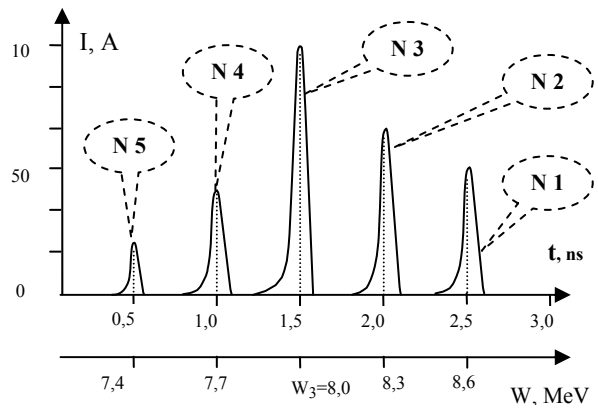

Fig. 3: Intrapulse structure of a bunch on accelerating frequency of 1886 MHz. The period of following of clots 530 ps

Compression Picoseconds Bunch

Distinction on energy between the next bunches provides an opportunity of a cutting collimator the separate chosen clot after spatial scanning pack with a rotary magnet (see Fig. 4). The current in windings of electromagnets is adjusted in limits 6-8A. At a current 7A collimator on an output of a magnet cuts out one of clots.

The bunch gets out of the middle of a package because of the greater difference in energy between bunches and the maximal current of the bunch. The allocated bunch is passed through the second electromagnet for a bunching of a beam, "clearing" of a gamma-background and is issued in the channel of transportation an atmosphere through foil window. Thus "parasitic" brake radiation from collimator is withdrawn aside from the experimental radiation-chemical equipment. The effect of a magnetic bunching is reached due to a difference of a course electrons inside a bunch. Electrons in "head" of a bunch have the big energy and are transported on trajectories with the big radius than "tail" electrons.

Thus "compression" of a bunch on time is reached and accordingly the charge of a clot (see Fig. 5, 6) increases.

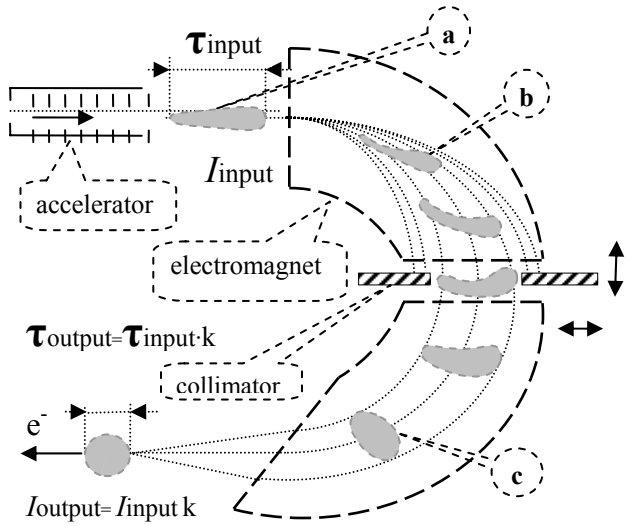

Fig. 4: Magnetic buncher and the circuit of its work: a) - intrapulse structure of the bunch; b) - a clot up to a magnetic bunching; c) - the bunch after a magnetic bunching.

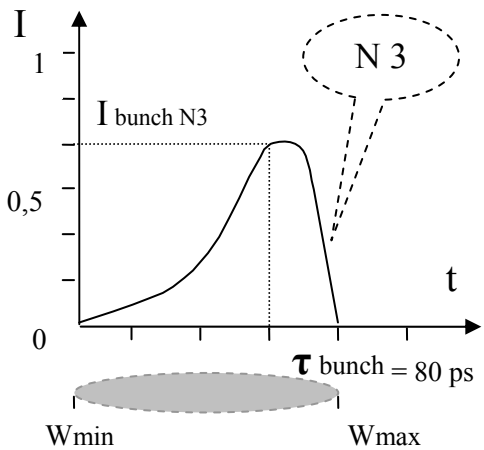

Fig. 5: A bunch № 3 up to a magnetic bunching.

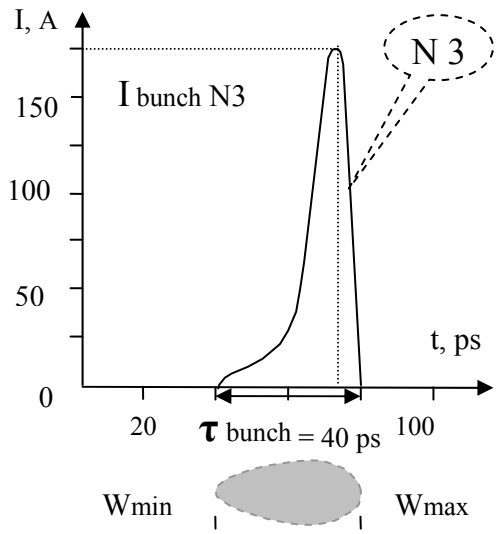

Fig. 6: A bunch № 3 after a magnetic bunching.

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DIAGNOSTICS OF A BEAM

On Fig. 7, 8 pulses on an output of accelerator UELV-10-10-T-1 are shown.

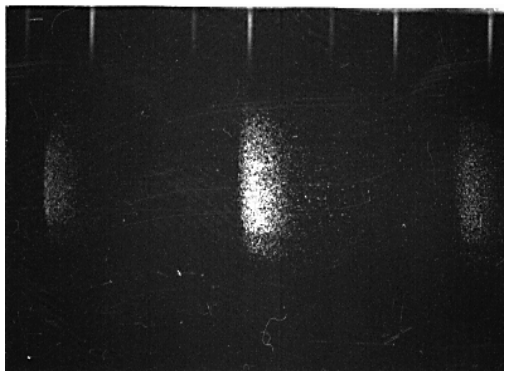

Fig. 7: Photoregisterogramma picoseconds a pulse.

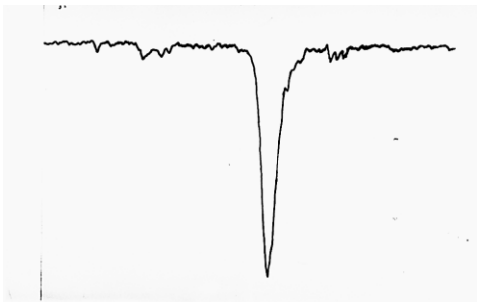

Fig. 8: Microdensitogramma picoseconds a pulse (50 ps, 150 A).

Picoseconds pulses from the accelerator are absorbed in a researched sample. In experimental pulse installation simultaneously through a sample light radiation from xenon lamps in a direction perpendicular to a beam electrons is passed. In a sample light is in part absorbed. Light past through a sample with the help of mirror optical system decays on a spectrum and is analyzed. Researches are carried out on spectrophotometer to diagnosing installation. (see Fig. 9).

Fig. 9: Appearance of system spectrophotometer to diagnosing installation.

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