MONITORING OF THE ELECTRON BEAM SIZE AND POSITION IN THE AIR

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Abstract

A possibility of the operative control position of the electron beam with energy from 20 to 90 MeV at the exit of two-structure electron linac [1] has been investigated. The irradiated samples are situated in free air of the linac bunker. Special secondary emission monitors are developed for the operative control of the beam position on the illuminated target. The monitor signals are used by linac control system.

THE MONITOR CONSTRUCTION

The monitor consists of three frames with two emitting and one collecting electrodes (Fig. 1). The collecting electrode is produced from the thin aluminum grid that applies positive voltage to $+Uc$. The emitting electrodes are perpendicular to each other and consist of aluminum lames of width 2 mm and 0.15 mm thick. The inner distance between frames are equal 2 mm. The frame size depends on the section quantity of the electron beam.

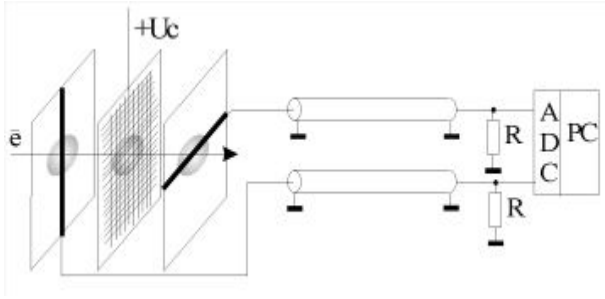

Figure 1: Monitor diagram. ADC - analog-to-digital converters, R - resistance to matche, PC - computer, e – electron beam.

When high-energy electrons pass through the lames, the positive signal is forming on the lames due to emission of secondary electron from the lame surface. The monitor signals by RK75 cable about 40 m in length is feeding to the digitizer entry [2]. The analog-digital converters with 8 digits provide the transformation of the analog monitor signals with discreteness 50 or 100 ns. Information about the signal parameters from the monitor is showing on the computer display of the linac operator.The centre of inner monitor window is integrated with the optical axis of the accelerator. The produced monitor complies with next requirements:

- the transparence for electron beam,
- the resistance to the radiation and thermal stability,
- the construction simplicity,
- the possibility for beam position control of the each accelerator pulse.

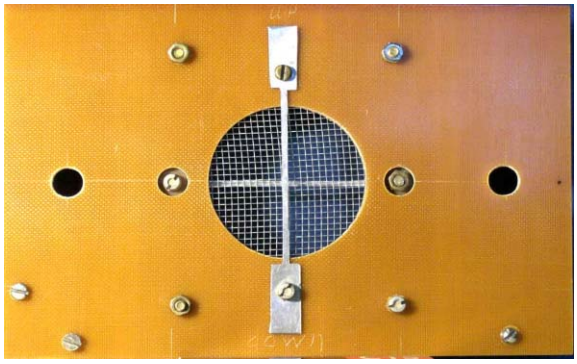

Figure 2: An external view of the prototype monitor.

THE EXPERIMENTAL RESULTS OF THE MONITOR USE

The monitor was put to a test in the process of the variety metal target irradiation on the LU-40m accelerator [3]. For irradiation the electron beam with energy to 63 MeV, pulse width 1.5 μks, current amplitude 60 mA and frequency of pulses 6 Hz was used. The target module was set not far (60 mm) from the exhaust foil in the air. The monitor was situated between the foil and front target surface with respect to the beam.

It was shown in the work [4] that secondary emission current from the aluminum lames is directly proportional to electron beam charge for the foregoing energy values. Fig. 3 gives pulse signal series from monitor lames. The pulse area is directly proportional to summary charge of the electron captured by monitor lames and depends on voltage value *Uc* (Fig. 4).

Beam cross-section diameter is estimated by the photometric method. Fig. 5 shows the example of the measurement.

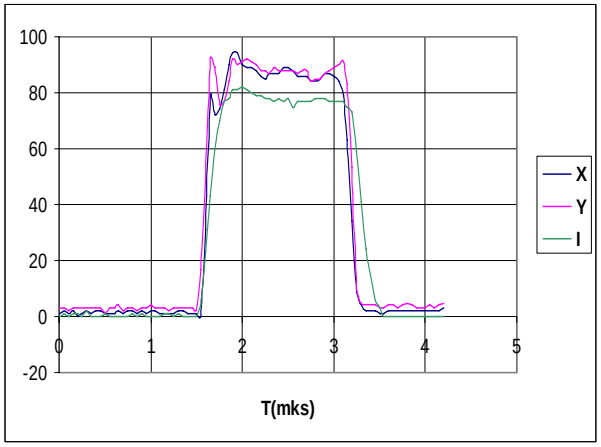

Figure 3: Videogram of the measurement process of the monitor signals.

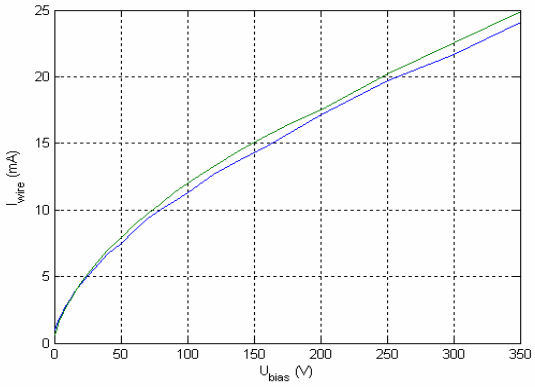

Figure 4: The pulse amplitude from the monitor lames related to the collecting electrode voltage.

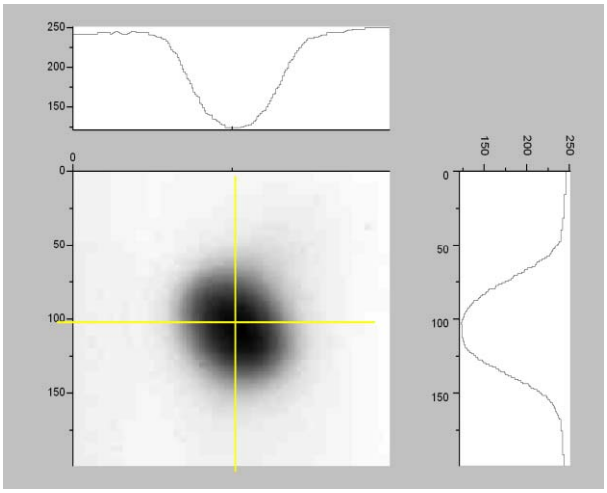

Figure 5: The photometry of the glass blackening by the action of the electron beam. Vertical and horizontal beam cross-section of the LU-40m accelerator. The image square is equal 20x20 mm.

If the collecting electrode voltage is equal +100 V, monitor current pulse amplitude is variable from 0 to 12 mA with the beam position. The center position and electron beam cross-section size on the target are selected at the beginning of the experiment by magnet power supply control system. In the process the monitor signals admitted to control and to optimize the size and the position of the beam on the target (Fig. 6).

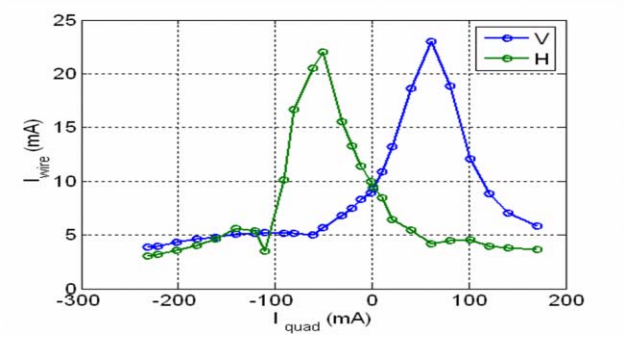

Figure 6: The monitor signal amplitude related to the current values in the corrective magnets.

The monitor outlined above is using successfully in the order of a year on the LU-40m accelerator. It is worthy note that more refractory electrodes are necessary during the analog monitor employment for the control of the more powerful beams. For example we were used the electrodes from the Ni-Cr alloy thin wires when operated at the beams with the energy 30 MeV, the pulse width 3.5 μks, the current amplitude 500 mA and the frequency of pulses 150 Hz.

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