MULTICHANNEL SYSTEM FOR RESEARCH OF SECONDARY EMISSION PULSE ELECTRON BEAM GENERATION*

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Abstract

Crossed-Field Secondary Emission electron sources have been investigated in the "Accelerator" R&D Production Establishment since 1993 . The main purpose of these investigations is the study of performances of such sources and the search of possible application fields. Experimental set-ups developed for investigations at the "Accelerator" R&D Production Establishment comprise: vacuum chamber with an assembly of secondary emission metallic cathodes under investigation, pulse high-voltage generator, assembly of magnetic field generation and measuring system. In the choice on the methods of measurement, it has been taken into account that the object to be studied has the following characteristics:

the output beam of the gun is a set of parallel electron annular beams with d from 5 to 8 mm (8 beams at the first stage) arranged on the diameter D = 44 mm (the number of beams and their mutual arrangement may vary);

total pulsed current of all the beams about 100 A;

current pulse duration - from 1 to 5 μs;

pulse-repetition frequency – from 1 to 12.5 Hz;

electron energy – up to 50 keV;

the electron beam source and the collector are in the constant magnetic field from 0.1 to 0.25 T.

To carry out above-described scientific-research developments we have designed and manufactured a 12-channel information measuring system. A hardware complex of the multichannel pulse-signal recording system is built up from a personal computer, crate CAMAC with modules, an interface unit and a synchronization system. The software of IMS operates in the Windows environment. It was written with the use of a visual object-oriented programming system C++Builder 5.

1 EXPERIMENTAL SETUP AND RESEARCH METHODS

The schematic diagram of experimental setup was gave and described in paper [1].. In Fig.1 are shown the system under investigation with cylinder anode and secondary-emission cathodes inside of anode. There are 8 copper secondary-emission cathodes (3) of 5 mm in diameter in the system. Cylinder diameter of the external anode (1) is 68 mm, cylinder diameter of the internal anode (2) is 20 mm. The anode cylinders are fabricated from stainless steel and are connected together with the help of metallic flange with holes for cathodes. For study parameters of each beam in detail are used section cooled Faraday cup and automated 12-channel information measuring system.

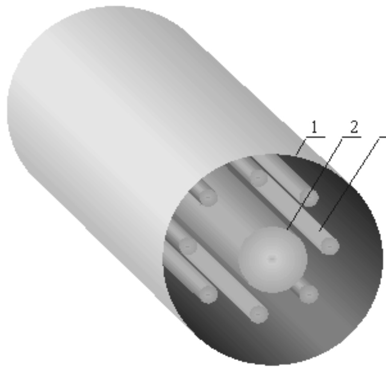

Fig.1. Multicathode system. 1, 2 – anode; 3 – secondary emission cathode.

The beam current is measured simultaneously for each beam The number of Faraday cups is equal to the number of beams. The electrons that have missed the cups arrive at a special insulated metal mask, which also serves as a collector. To study space and time homogeneity of one beam one of the Faraday cups is overlapped by a special silver screen with a thin (Δ = 0.5 mm) radial slit. This allowed to estimate of beam transverse size during observation of beam glow.

The signals from each of the Faraday cups and masks via coaxial cables arrive into the block of matched attenuators. The passband of channel is 350 MGHz. The block of matched attenuators makes it possible to match the amplitude signals for the subsequent conversion in ADC. The Faraday cups are cooled by contact through a thin insulating spacer with a water-cooled metal plane. A special channel with a passband of up to 12 GHz was provided for investigations of microwave signals arising during the gun operation. . It consists of an inductive probe and of a coaxial line with a wide-band coaxial connector. A simplified layout of the Faraday cups is shown in Fig.2. Each author should submit all of the source files (text and figures), the postscript file and a hard copy version of the paper. This will allow the editors to reconstruct the paper in case of processing difficulties and compare the version produced for publication with the hard copy.

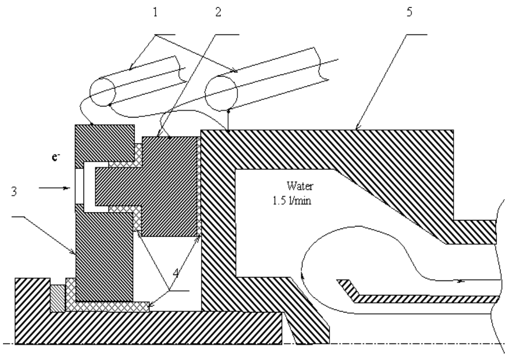

Fig.2. The Faraday cup disposition diagram.

1 – coaxial lines, 2 – Faraday cup, 3 – mask, 4 - insulators, 5 – cooled chamber .

2 INFORMATION MEASURING SYSTEM (IMS)

To carry out above-described scientific-research developments we have designed and manufactured a 12-channel information measuring system. IMS makes it possible to measure the amplitude-time characteristics of signals, operative processing of acquired data and recording the information obtained on magnetic disks.

2.1 Hardware of IMS

A hardware complex of the multichannel pulse-signal recording system (fig.5.7) is built up from a personal computer (PC), crate **C**AMAC with modules, an interface unit and a synchronization system.

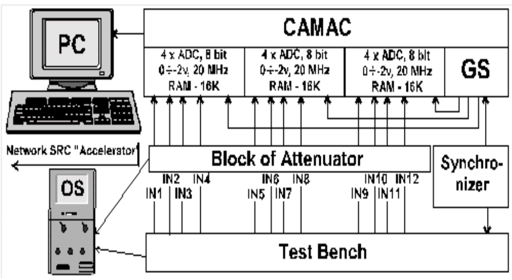

Fig.3. Block diagram of the multichannel pulse-signal recording system.

Pulse signals are recorded by means of three special ADC and generator-synchronizer (GS) with a discreteness of 50 ns or 100 ns simultaneously from 12 channels.

Each ADC module contains four independent channels. The memory capacity of each channel is 16 K. For the development we have used a microcircuit of the firm Analog Devices (AD 9200). The dynamic range of measurement on the amplitude is 0, -2 volts.

The number of discreteness levels on the amplitude is 256. The amplitude characteristic of one module is given in fig.4. The equipment is entirely made in accordance with the CAMAC standard. The operative information is displayed on the color graphical display of the PC (fig.5).

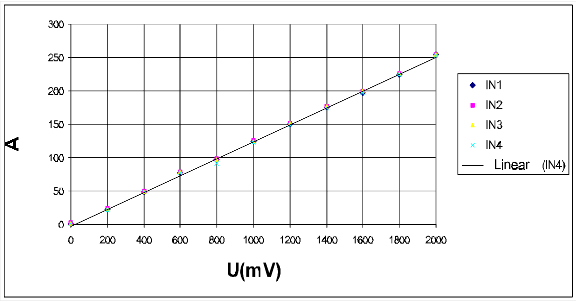

Fig.4. Amplitude characteristics of four channels of one from the ADCmodules

2.2 Software of IMS

The software of IMS operates in the Windows environment. It was written with the use of a visual object-oriented programming system C++Builder 5. With the help of special menus (see fig.5) the researcher can preset a time interval of measuring, quantity of pulses measured and discreteness frequency, specify a number of measuring channels and choice a single or cyclic mode of measuring. After finishing the measurement cycle for each channel the following is displayed (Fig.5):

mean amplitude of the measured pulse train (A) in relative and physical units;

coefficient of maximum pulse amplitude deviation from the mean value (Km%);

mean pulse duration T_p and delay of the pulse leading edge T_d relatively to the synchropulse;

mean value of the area under the pulse – Sum.

The plots of time characteristics of measured pulse trains and the histograms of distribution of charges from the Faraday cups connected to the first ten IMS channels are displayed at researcher's will. Using the light button "Page" one can survey all the pulses of the train.

For the subsequent processing the researcher can store the measured data complementing them with his commentaries.

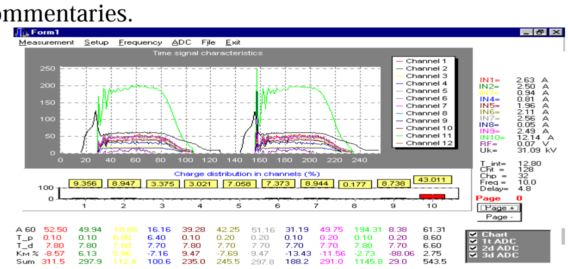

Fig.5. Example of system operator interface .

Engineered system may be used for recording of intelligence signals from pulse linear electron accelerator and other experimental setup.

3 REFERENCES

[1] Ajzatsky N.I.,.Boriskin V.N, Dovbnya A.N. et al., "Electron beam production in multicathode secondary-emission systems", Proc. EPAC'02, Paris, June 2002.