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DOPPLER SPEEDOMETER FOR MICRO-ORGANISMS

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Beginning with the day of its foundation, INP has solved the fundamental and applied problems related to the interaction of elementary particle and light nuclei with a substance, the problems of nucleus fission physics, solids physics, instrumental provision of nuclear physical investigations. Nowadays the most efforts are applied to solution of ecological problems.

The authors of the proposed project are experienced in the following fields:

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chemistry, plasma electrochemistry;

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mechanics of deformed solids , laser optics, industrial electronics;

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biophysics, laser correlation spectroscopy, thermal physics, theoretical nuclear physics;

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mechanics of deformed solids, laser optics, creation of industrial devices for plasma coatings;

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X-ray spectroscopy, biophysics, creation of industrial devices for plasma coatings.

Objective of Investigations: Development and creation of the Doppler speedometer for micro-organisms which allows to evaluate, in a real temporal scale, variations in the state of water suspension of micro-organisms under the effect of chemical, physical and other external actions.

Background: Suspensions of micro-organisms are widely used in biology, agriculture, ecology, etc. Fluctuations of its parameters are known to contain an important information. The observable are the motion speed and a fraction of mobile cells. These parameters change versus time, having both the monotone component, e.g. when cell perishing, and a variable component - periodic decrease of the motion speed and the fraction of mobile cells. Variation of the motion parameter versus time can play a role of the measure for a state of cell population. In particular, the motion parameters, practically, instantaneously vary when the water solution composition changes or under the action of toxicants, etc. The parameter variations give a chance to determine the specific values of concentration which correspond to the limiting allowed ones or to the mortal doses. Standard biological techniques require several days or weeks of observation of mass changes in a population, whereas the fluctuations in motion speeds give an answer in a few minutes. These statements are based on the original works : AC No. 1482887 "A way of evaluation of toxic action of the chemical compounds contained in water medium", priority dated 10.06.87, published 01.02.89; AC No. 1688161 "A way of determination of toxic effect of chemical compounds

contained in water medium on culture of plankton hydrobionts", priority dated 11.12.87, published 01.06.91; the claim No. 4193708 Y A way of evaluation of sperm quality", priority dated 10.01.87; and publications in the Journals: "Biophysics", v. 33, No.4, 1988 - in Russian; "Molecular Genetics and biophysics", v.13, 1988 - in Russian; "Biological Science", No. 10, 1988 - in Russian.

Statement of the Problem The main problem is absence of reliable, accessible for users and simple, in view of application, Doppler speedometers for micro-organisms. Nevertheless, correlation Doppler spectrometry in the regime of heterodyning the supporting and cell-scattered laser radiation is well known. The main idea is that the correlation function of photo-current pulses bears an information on the averages over the assembly of cell velocities. For solving the biological problems, construction of auto-correlation function in the real-time regime with the delay time values comprising, function in the real-time regime with the delay time values comprising, nearly, 100 mc (10 kHz) or higher is needed. Computers of the "Pentium" class manage this problem using but the program software. Due to this, one can simplify applications of the proposed techniques provided he creates the Doppler speedometer for micro-organism on a base of the "Pentium".

Scope of Activities In the course of project execution the following works are to be done:

Development and manufacture of the optic-electronic block involving:

- a helium-neon laser of the power lower than 10 MWt;
- a thermal-stable dish having an option of optical alignment and registration of scattered light for laser emission heterodyning;
- a photo-recording device with an optical system for collection of scattered light and the supporting beam at a photo-diode;
- an amplifier of constant current (amplification up to 10,000 within the range 0 to 10 kHz);
- an amplitude digitiser and a block of communication with a computer, which provides the standards of signal transmission both in series and in parallel.

Development of the device software, including:

- a code-auto-correlator capable to build auto-correlation function over 16 to 128 points with the delay ties not less than 100 ms;
- a code for extraction of the motion parameters from the correlation function;
- a code for data flow processing and control;
- a code for the experiment service;
- applications for specific device options.

Expected Result Manufactured operable mock-up of the Doppler speedometer for micro-organisms in a form of the auxiliary computer block which allows to receive an information, in the real time scale, on the results of external effects of various nature on the cell assembly in transparent medium with a small volume of the studied cell suspension.