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CONTENTS

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THE USE OF COMPUTER TECHNOLOGIES FOR THE DETERMINATION OF ENERGY CONSUMPTION AND ASSESSMENT OF ENERGY INTENSITY OF LIVESTOCK-BREEDING

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The article represents the description of the developed computer program, that makes it possible to analyze actual consumption of electric and heat energy at livestock farms, to compare it with current energy norm sand to plan long-run energy consumption.

Keywords: *electric and heat energy consumption, livestock-breeding, pig-breeding, energy intensity.*

Introduction

The problem of reduction of energy costs per production unit, that is, reduction of energy intensity of production and increase of its energy efficiency, is one of the most significant directions of the development of agricultural production. Consumption of energy – both electric and heat – accounts for a larges hare of production cost of agricultural products. The implementation of advanced technologies and equipment, the up grading of energy supply systems and tariffs growth predetermine revision of standard indicators of energy consumption in production, as well as the method soft heir calculation. In this process it is advisable to use the possibilities of information technologies.

In planned economy rates of energy consumption were developed on an average basis which did not allow to consider the specifics of technologies of a particular production process. Currently, such approach does not meet the requirements and conditions of production. The range of applied technologies, equipment, livestock number and structure is extremely wide and does not allow to apply averaged indicators, as every enterprise with specific production conditions as to solve the problem of raising efficiency of fuel and energy resources use. The process of calculation and analysis of actual and planned indicators of energy costs is labor and time consuming. The use of readings of energy meters does not allow to carry out detailed analysis of energy costs of equipment, processes, premises, to determine the most energy consuming production are a sand precisely plan measures to raise energy efficiency of production.

Results and their discussion

For this purpose VIESH specialists have developed the automated program for the determination of energy consumption in livestock breeding (as an example of pig-breeding farms) on the basis of the previously developed method sand algorithm presented at Fig. 1.

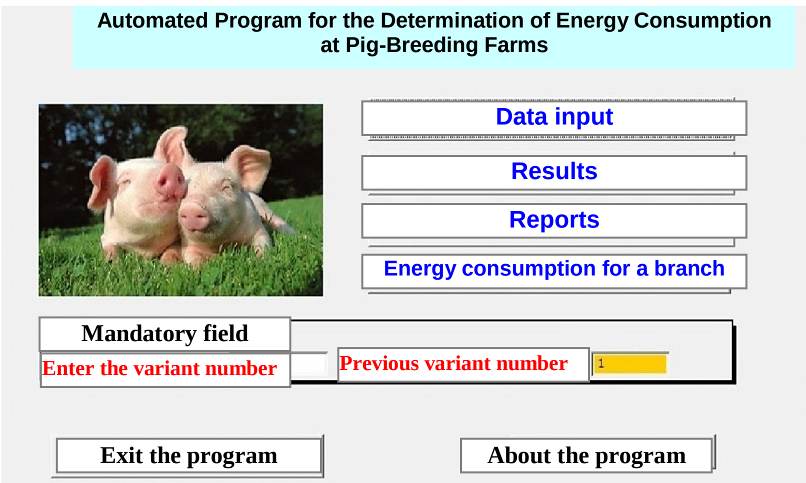

Fig. 1. External view of the program

This program is designed for the realization of an automated system of determination of energy consumption at all levels of industrial structure of production, as well as for the determination of energy demands at an enterprise, at a farm or in the industry in the whole in a specified time period.

The algorithm for determination of energy consumption in livestock breeding at all levels of industrial structure is presented at Fig. 2.

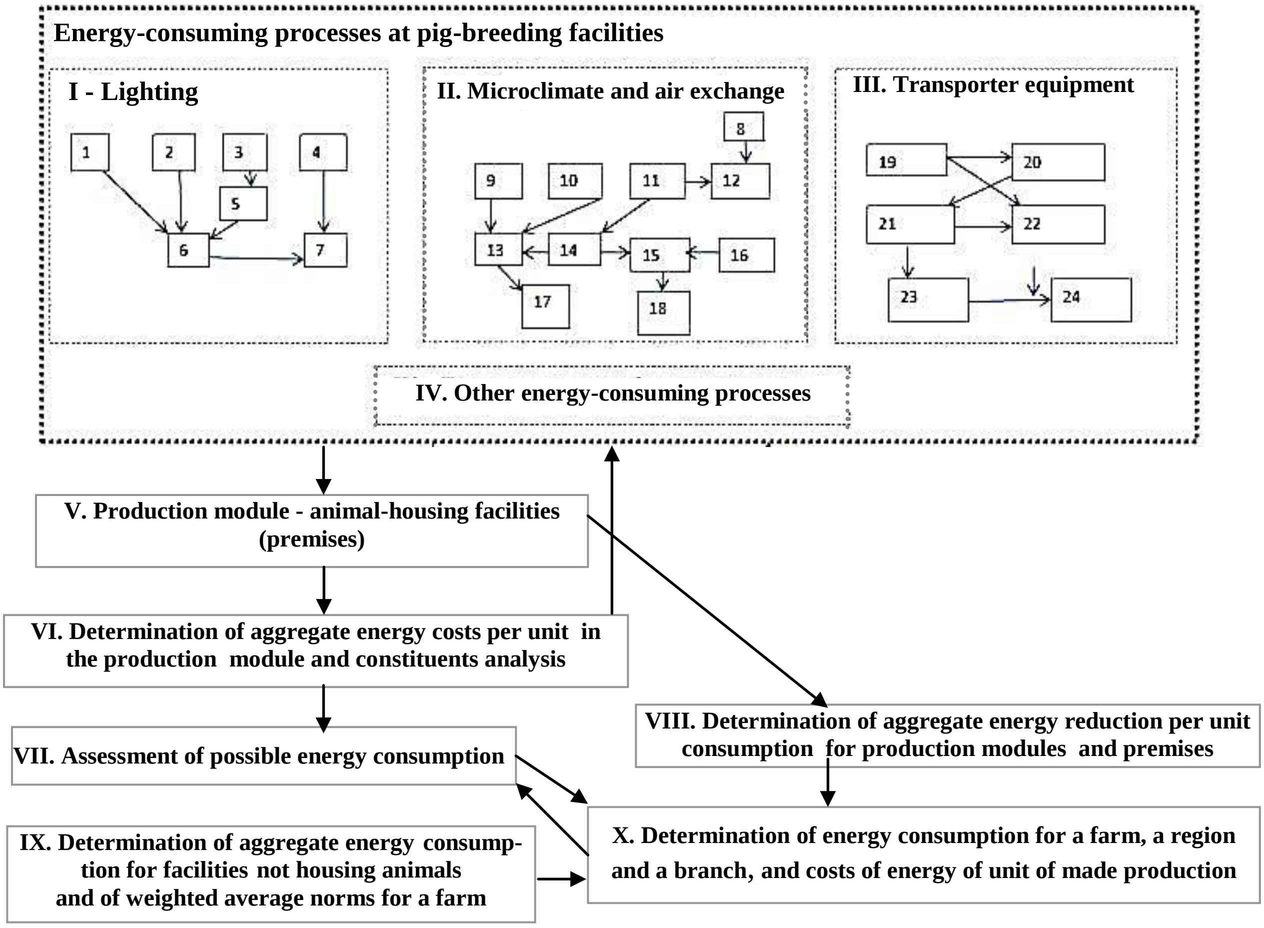

Fig. 2. Algorithm for determination of energy consumption at all levels of industrial structure with due consideration of influencing factors

The block “Energy-Consuming Processes” comprises all the production processes whose implementation requires energy consumption. 1-7 – factors influencing the level of energy consumption in the process of lighting (the type of lighting equipment, length of light, required illumination, etc.); 8-18 – factors influencing the level of energy consumption in the process of microclimate control (required temperature, air humidity, types of ventilation and heating devices being used, etc.); 19-24 – factors influencing the level of energy consumption in the processes of feeding and manure removal. In a similar way in the block “Other Energy –Consuming Processes” other production processes with influencing factors are presented.

The program user can get various data selection related to the specifics of a particular production enterprise. In the section “Data Input” the user is offered to enter information concerning current number and structure of livestock and to select technologies of animal management and equipment types. For example, the calculation of energy consumption in feeding process can be carried out for the following feeding types: dry, wet and compound. The calculation of energy consumption for lighting can be carried out for various lighting devices – incandescent, luminous compact luminous and LED-lamps. The calculation of energy consumption for ventilation process can be carried out both for forced air supply and removal and for free air flow and forced exhaust air removal.

The calculation of heat energy consumption can be carried out for various types of enclosures with specific heat characteristics and for different values of spatial stocking density.

The program provides execution of the following functions:

- Ensures various combination of processes and technologies while determining energy consumption of a particular enterprise;
- Determines energy consumption for facilities, enterprises, industry;
- Allows to get selection of versions of energy consumption for various processes for a specified time period;
- Determines weight-average indicators of energy consumption, products energy intensity, energy demands;
- Results output for further analysis;
- Automatic reports generation (section “Reports”) for energy consumption of electric and heat energy for various groups of animals and premises.

The Program makes it possible to calculate energy consumption in an interactive mode thus providing comparative analysis of results entering various data characterizing production conditions, as well as energy supply systems and utilities. It allows to carry out assessment of suggested energy-saving activities.

Conclusion

The developed computer program has passed state registration. It is designed to be applied for calculation of energy consumption at pig-breeding farms, at research and engineering organizations and educational professional institutions.

The Program makes it possible to carry out calculation and analysis of actual energy consumption at animal-breeding facilities and farms, as well as to forecast demands for energy resources on a short-term and long-term horizon.

The use of the Program does not require additional training as the interface is self-intuitive.

The Program is based on the use of methods of determining energy consumption norms and demands for energy resources as example fied by pig-breeding farms. The methods have been developed by VIESH specialists.

The “Automated Program for the Determination of Energy Consumption at Pig-Breeding Farms” has been given toanumberofpig-breedingfarmstobeusedforassessmentofenergycon-sumptionunder real production conditions.

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WAYS OF THE ORGANIZATION OF ELECTRICAL SAFETY PRODUCTION

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The solution of problems of support of adoption of operational decisions on ensuring electrical safety of production, and also effective preparation and certification of the personnel for electrical safety with application of means of an intellectual program complex of ensuring electrical safety of production is considered.

The intellectual program complex in a mode of dialogue develops rational decisions on increase of level of electrical safety with use of procedures of the target expert systems built and filled by data and knowledge depending on objectives for automation and achievement of necessary quality of the main professional and production functions of the labor protection specialist (electrical safety). For support of process of search of decisions and their assessment intellectual software use the approaches imitating actions of workers, organizing information processing similarly to the processing made by the person, including interactive dialogue systems of planning, optimization and decision-making.

Network intellectual program complexes of preparation and certification of the personnel for electrical safety of production in the network hardware environment realize remote and network training and personnel examination according to the allocated sections of safety of production and realize expeditious control functions of the administrator of a program complex – the expert responsible for preparation and examination of employees of all production structure (the region, association), including territorially separated substructures and divisions.

It is possible to carry the indicators allocated in five groups to indicators of efficiency of functioning of intellectual program complexes: efficiency of information support; quality of software; operational characteristics; quality of made decisions; quality of preparation and personnel certification.

Keywords: *electrical safety, electro traumatism, incidence, working conditions, certification of personnel.*

The condition of electrical safety at any enterprise is defined by result of interaction of four groups of actions, including measures for the organization of electrical safety production, improvement of a design of the electrified cars, the equipment, installations, to application of new technical means of an electrical protection and effective remedies of individual protection working in electrical installations.

In due time to appoint rational actions, to control their execution and efficiency of application, quickly only intellectual program complexes which are based on information and communication technologies with application of expert methods and ways, the formalized knowledge of highly qualified specialists of electrical safety are capable to correct them depending on changes in real production.

Tasks support operational decision-making to ensure electrical safety of production, and also effective preparation and certification of the personnel for electrical safety are solved means of an intellectual program complex of ensuring electrical safety of production (IPC EEP). The functional structure of IPC EEP is shown in Figure, where the following designations of functional blocks are applied: 1 – Information carriers; 2 – Means of communication of information; 3 – Electrical traumatism; 4 – Incidence; 5 – Means accumulation and processing of information; 6 – Working conditions; 7 – Knowledge of electrical safety; 8 – Primary documentation; 9 – Instrumental environment; 10 – Knowledge of qualified professionals; 11 – Database and knowledge; 12 – Extraction and formalization of knowledge; 13 – Dynamic expert system; 14 – Decision-making; 15 – Authorization of access to modules and tasks; 16 – Intelligent interface of the user; 17 – Personnel (all employees); 18 – Accidents (electrical traumas); 19 – Incidence; 20 – Working conditions; 21 – Planning (plans, programs); 22 – Documentation (working, reporting); 23 – Control of execution of decisions; 24 – The personnel (the trainees, certified, responsible for preparation and certification); 25 – Preparation; 26 – Certification conditions; 27 – Certification; 28 – Documentation (operating, reporting); 29 – Elaboration of operating influence; 30 – Operating influence; 31 – Organization of electrical safety of production; 32 – The user of IPC (the labor protection specialist (electrical safety) responsible for preparation and certification, the trainee, the certifying); 33 – Condition of electrical safety and working conditions on a workplace.

The most effective way of realization of actions for decrease in production electrical traumatism and to improvement of working conditions in production electrical installations is the automated decision-making on ensuring electrical safety of the production, real conditions of the production environment considering factors, the economic resources of the enterprise allocated for ensuring electrical safety, and the formalized knowledge of ensuring the electrical safety, transformed by software in rational decisions in concrete production.

The intellectual program complex of support of decision-making on ensuring electrical safety of production (IPC SDME) represents the set united by information and communication process technical and software, telecommunication and computer systems and the expert technologies functioning in interrelation with the user, capable on the basis of data and knowledge to synthesize the purposes and to develop rational faultless decisions on achievement of the objectives – to prevention of production the electrical traumatism, prevention of incidence and improvement of working conditions working in the electrical installations [1…4].

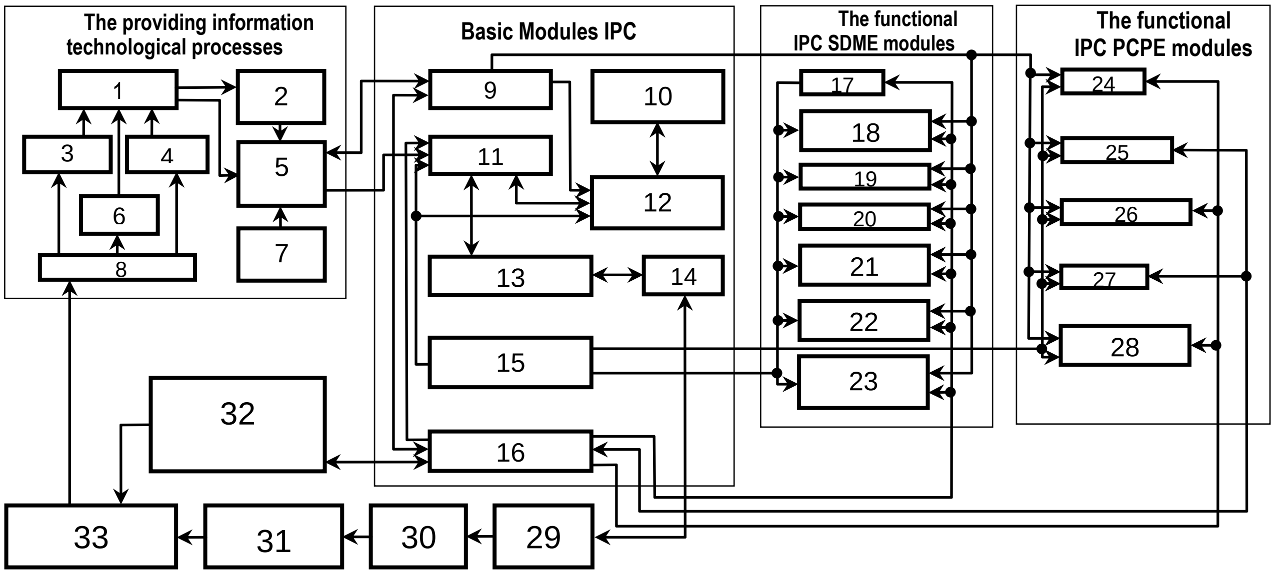

Fig. 1. Functional and technological structure intellectual program complex of ensuring electrical safety of production

Data and knowledge of a condition of electrical safety of production are formalized and collect in databases and knowledge of dynamic expert system. Resources of databases and knowledge are used for synthesizing of the purposes and local goals on decrease in production electrical traumatism, prevention of incidence and improvement of working conditions in electrical installations. Means of dynamic expert system make the decision and the operating influences which results of action can be predicted by the block of forecasts are developed and are considered at acceptance of a final decision by dynamic expert system. Made decisions are systematized and take place in a database and knowledge.

The information carriers applied at formation of databases and knowledge of IPC SDME, are interconnected, have computer screen images and the corresponding program maintenance, provide the unambiguous characteristic of an electrical trauma, the exception of minor information, achievement at their filling with persons of different qualification, with a different education level of full comparability of data, their necessary completeness, reliability and efficiency is production the caused disease and working conditions on a workplace with electrical installation.

Procedures of setup of information carriers on a certain production from any terminal device with authorization of access to this procedure, additions of limited number of not used consistent values of characteristics supporting possibility in adjusted sections that guarantees the fullest reflection of specifics of concrete production, working conditions, features of circumstances of accident are provided, is production the caused disease and information needs of specific labor protection specialists (electrical safety) with obligatory saving of the data reflected by similar existing primary documents. Information carriers can carry out a role of primary documents in the form of firm copies if they contain all necessary data and are signed by officials (with possibility of use of a digital signature).

The intellectual program complex in a mode of dialogue develops rational decisions on increase of level of electrical safety with use of procedures of the target expert systems built and filled by data and knowledge depending on objectives for automation and achievement of necessary quality of the main professional and production functions of the labor protection specialist (electrical safety). For support of process of search of decisions and their assessment software of IPK use the approaches imitating actions of workers, organizing information processing similarly to the processing made by the person, including interactive dialogue systems of planning, optimization and decision-making.

Developed decisions are among innovative solutions to which it is possible to refer application of technical means of an electrical protection with earlier not realized functionality, including functions "friend or foe", executive bodies on currents of leak not only on the earth, but also between wires of an electric network in a protected zone, on wire break before its falling on the earth, operation on a radio signal, etc. If necessary executive bodies of devices of an electrical protection have to be coordinated from by all means mobile communication, have an independent (individual) source of power supply.

To innovative means of individual protection (MIP) working in electrical installations easy shielding sets for works energized, executed of fabrics effective electrical conductive, strong, environmentally friendly and harmless to the person with the properties increased by application the nanotechnological of methods, convenient and steady in a sock and application, MIP (dielectric gloves, mittens, footwear, helmets), preventing electrical defeats can be carried, for example, at a touch to current carrying and conducting parts under any tension, thermal burns of any character, radioactive and bactericidal influence.

Developed decisions are shown in two options – completely corresponding to the saved-up decisions in the knowledge base or the adapted new decisions which are reflecting knowledge of the user of a program complex and not reducing degree of correctness of earlier saved up decisions on similar circumstances.

Along with development and timely application of effective decisions on protection working in electro installations from electrical traumatism and occupational diseases the most important condition of creation of electrical safe production is the trained personnel. Necessary professional level, stability of safe production skills is provided with the organization of training and examinations of workers not formal effective remedies and methods. Intellectual program complexes of preparation and certification of the personnel for electrical safety of the production (IPC PCPE), based on expert methods and the information and communication technologies, the containing formalized knowledge in a text and graphic look, represent the modern computer and telecommunication resource, allowing to equip production by tools for the effective solution of all operational tasks on training and control of knowledge of the personnel in the organizations and at the enterprises with application of actual knowledge of electrical safety and labor protection [5…7].

The IPC PCPE functional modules provide the fullest formalization of existing normative documents and rules on labor protection and electrical safety of production in the form of questions, answers and graphic descriptions; convenient and controlled preparation of the personnel; objective and timely certification of knowledge of workers; continuous control of execution of terms of certification; the automated maintaining and the printing of working and reporting documentation on results of preparation and control of knowledge of the personnel; openness of a program complex; simplicity of its operation.

IPC PCPE as the open program cover, allows the expert organizing training and control of knowledge to concentrate any professional data on the personnel having training, instructing and certification, is automated to carry out these procedures, and also to form the necessary, reporting documents established by existing requirements. Openness of program complexes is reached also by possibility of replenishment by not programming user of the formalized knowledge in the form of text and graphic descriptions (set of questions and the answers, the interconnected graphic images), formations of new sections (new target systems), creations various, meeting the requirements of concrete production, options of certification.

The module of preparation is available to the trainee on a certain workplace without any control by the expert responsible for preparation, both before certification, and after it, with possibility of renewal of training from any necessary question or a situation from previously appointed group, and necessary completeness of used information resources is provided with the chosen conditions.

Conditions of certification are regulated depending on arising production requirements and describe control programs of various professional levels and production scopes of application. Procedure of certification is carried out according to earlier created conditions (options), including with being in the network authorized access, and shows a series of questions and graphic descriptions by separate fragments of knowledge. Fixation of the general time spent by the worker at certification is provided.

Output documentation of IPC PCPE has flexible structure adjusted by the user and reflects the established existing requirements to reporting documentation and need of the user for fixation of data, knowledge and the data necessary for the organization of effective preparation, instructing and personnel examinations in production.

Network versions of IPC PCPE in the network hardware environment realize remote and network training and personnel examination according to the allocated sections of safety of production and realize expeditious control functions of the administrator of a program complex – the expert responsible for preparation and examination of employees of all production structure (the region, association), including territorially separated substructures and divisions.

It is possible to carry the indicators allocated in five groups to indicators of efficiency of functioning of IPC: efficiency of information support; quality of software; operational characteristics; quality of made decisions; quality of the training and certification of personnel.

Information carriers of a program complex provide the expeditious automated collecting and accumulation of a solid data about accidents (electrical traumas), diseases, working conditions in electrical installations in necessary volume, possibility of rigid feedback for control of results of impact of entered preventive actions on a condition of electrical safety of operating production with territorial and personal indexation.

The new system of the accounting of data on a condition of electrical safety allows to receive the unambiguous characteristic of an electrical trauma, a disease and working conditions on a workplace and practically to exclude minor information; to provide full comparability of the information carriers given at filling with the personnel of different qualification; sharply to reduce time of registration of data on an electrical trauma, a disease and working conditions in electrical installations; to show to users of IPC and consumers of information carriers of information in two options – in the form of an electronic image and in the form of the firm copy; objectively in a complex to estimate a condition of electrical safety and electrical safe working conditions at the organizations the interconnected operational account and the analysis of data on production electrical traumatism, incidence and working conditions.

At development and decision-making on ensuring electrical safety of production generally for an assessment of its efficiency technical, economic and social aspects are allocated. Technical efficiency is defined by the accuracy and completeness of implementation of the made decisions on ensuring electrical safety of production. As criteria of profitability of software on decision-making demanded machine resources, time of search of the decision and more integrated indicator – costs of search the decisions considering expenses of manual and machine time for search of the decision, an hourly average rate working at IPC are considered.

The social aspect of quality of made decisions is connected on the one hand with decision-making of IPC forming conditions for ensuring electrical safety of production, preservation of human resources, health working which can be characterized by economic indicators by the corresponding techniques. With another – process of development of decisions differs high technological effectiveness, meets the high requirements of ergonomics and turns work of the expert responsible for a condition of electrical safety, in creative and attractive.

It is necessary to refer to parameters of efficiency of IPC also decrease in deficiency attracted for preparation and certification of the qualified teachers, administrative workers and technical instructors; elimination of need of systematic business trips of the qualified experts who are a part of examination committees; single input of basic knowledge and their repeated use at any level in hierarchy of management of safety of production; fast finishing to knowledge certified of necessary volume with use of usual communication channels for support of relevance of information and intellectual filling of system; reduction of cost of one school hours; reduction of terms and increase of objectivity of training and certification; the individual automated form of preparation and control of knowledge within a certain qualification program according to specifically established purposes; computer support of creative abilities and intellectualization of work of teachers and trainees; considerable decrease in the expenses connected with preparation of the personnel, mainly due to decrease in number attracted at the organization of training and certification of experts; increase in life expectancy and especially its active able-bodied period due to timely observance by the worker of safety requirements when performing production operations; depth and stability of acquired skills and the knowledge promoting adoption of rational safe decisions in real production; reduction of wear or release of the equipment and the units applied for training; possibility of improvement of modules and components of a program complex not programming professional.

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OFF-GRID PHOTOVOLTAIC SYSTEM WITH LED

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The off-grid photovoltaic system with batteries and with the LED light source was constructed and tested in our laboratory. The PV system is used for energy accumulation during the day, for illumination during the night and it is independent of the electric grid. Description of the construction and testing is presented in this paper as well as results of the tests.
Keywords: *solar energy, PV system, LED, illumination.*

Introduction

The off-grid photovoltaic (PV) systems are usually installed for energy supply in locations where the grid is missing or where the device must be self-sufficient. The energy accumulation into the batteries can continue during the day in the case of the off-grid PV system. The accumulated energy is suitable for energy supplying of various equipments or science instruments in the off-road conditions. We constructed and tested various on-grid and off-grid PV systems in the past and our results were published regularly for example in the journal Solar Energy Materials and Solar Cells (Poulek V., Libra M., 1998; Poulek V., Libra M., 2000) or in the book (Poulek V., Libra M., 2010). Recently, we constructed the off-grid PV system for illumination. The energy saving light source with light emitting diodes (LED) was used and the PV system was tested in our laboratory. This paper presents the results of the construction and testing.

The construction of the PV system was the main aim. Consequently, the parameters optimization and functionality verifying in long-term operation were the next aims.

Suitable light sources

The energy saving light sources based on LED are the most suitable. The efficiency of the yellow LEDs is up to $\eta \approx 40$ %. LEDs producing white light have efficiency approx. $\eta \approx 30$ % and the lifetime approx. 50000 h. So we used the light source based on the LEDs emitting white light, it is more expensive in comparison with other light sources, but the technical parameters are most important. Especially the efficiency of the energy conversion is most important. The batteries are more slowly discharged in this case. We hope that the larger volume of the production will decrease the price in the future.

Incandescent lamps are discharging the batteries too fast. The tungsten filament inside the bulb emits the light according to Planck‘s law about radiation of the dark body. The efficiency is approx. $\eta \approx 3$ % and the lifetime is only 1000 h. The discharge light sources (for example fluorescent lamps) have efficiency approx. $\eta = 18$ % and the lifetime approx. 5000 h.

The LED emitting white light is suitable light source, the diodes emit blue spectral lines and the other spectral lines in the visible spectrum are generated by luminophore. The resulting colour of the light is white.

Experimental arrangement

We constructed the small off-grid PV system designated for illumination in our laboratory. Fig. 1 shows the outdoor section. The batteries were located in the laboratory as well as the recharging unit and programmable unit (PLC). The data were collected on the memory card and the visual supervision was possible using the web interface. Fig. 2 shows scheme of the off-grid PV system. The nominal power of each diode was 1 W, the total number of diodes was 30. So, the maximum total input power was 30 W during the operation and it could be influenced by ratio between switch on and switch off times at higher frequency. The recharging unit L2415 was used for the batteries charging. This unit controled the recharging and it also secured the over-voltage and under-voltage protection. The PV panel based on the monocrystalline silicon with maximum output power P = 170 W_p was used for the recharging of lead gel batteries EnerSys (12 V, 105 A.h). Two batteries were connected in serie and the no load voltage was approx. U_e = 28 V if fully charged. The maximum value of accumulated energy was approx. W_{max} = 2,5 kWh.

The construction of the PV system was realised in the year 2011 and the operation data collection started in August 2011.

Fig. 1. The outdoor section of the off-grid PV system

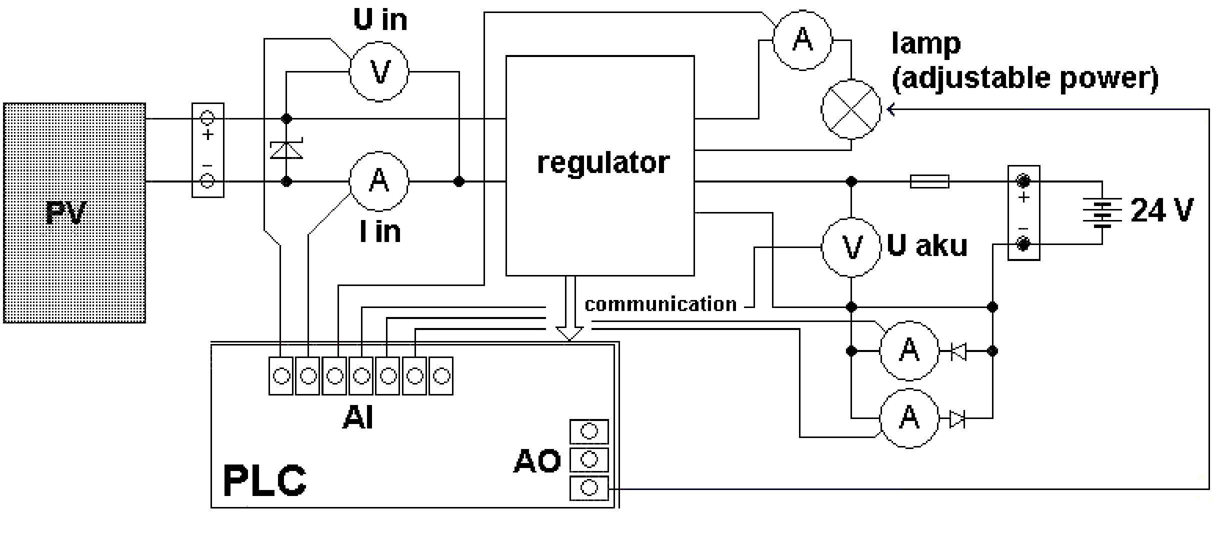

Fig. 2. The scheme of the off-grid PV system

Results and discussion

Initially, the illumination mode started at 21:00 and finished next day at 6:30. The daily illumination time was almost 10 hours and the output power was 30 W. The batteries were charged during the day by the PV panel and they were discharging during the night by the light source. Till the 3rd November the charging and discharging were in a balance (in Prague, 50° north latitude).

The calculation according our previous measurements (Libra M., et al., 2010) shows that during the whole year the PV panel is capable of supplying energy of more than $W_s > 150$ kWh. If the light source would be switched on for 10 hours per day, the energy of $W_o \approx 110$ kWh would be needed for a whole year, the efficiency of the batteries is approximately 70%. According to the calculation, the PV system could be theoretically self-sufficient during the whole year. It was self-sufficient during the summer period till autumn 3rd November. No additional energy can be stored, if the batteries are fully charged. Also we must expect a part of wasted energy. During the winter period the time of sunlight is shorter and the angle of the solar radiation is lower (Poulek V., Libra M., 2010). Ageing, energy losses and decreasing of the batteries capacity must to be also taken into the consideration. That is the reason, that the PV system was not self sufficient after the 3rd November 2011. For that reason, we changed the illumination mode. The light source was shining during the evenings and mornings with 50% of the illumination capacity and during the night with 30% of the illumination capacity. The illumination intensity was controlled by the ratio between switching on and switching off time at the higher frequency. The balance between the charging and discharging was restored and the PV system was operating reliably within next whole years.

Figs. 3, 4 show the dependences of the batteries voltage and of the electric current cross the light source on the time during few selected winter days and few selected spring days in the year 2013. There the situations in the winter period (Fig. 3) and in the spring period (Fig. 4) are seen. No problems with the under-voltage protection were observed after the modification of the illumination mode (lower illumination intensity and intput power).

The economic calculation says that the entire system can be bought for a price of 800 Euro. The most expensive are used rechargeable batteries (approx. 440 Euro), PV panel (approx. 140 Euro), the light source (about 100 Euro), programmable unit (PLC) (approx 40 Euro). If the lamp is operating approximately 13 hours a day to an average of 40 % power (see Figures 3 and 4), the daily energy consumption is about 0.16 kWh and about 60 kWh per year. The price of the energy from the network is approximately 12 Euro/year. In five years of operation, which is about the life of the battery, the system would save about 60 Euro. It is therefore clear that its usage can not be motivated by saving money on energy, but either on the grid or network is unavailable.

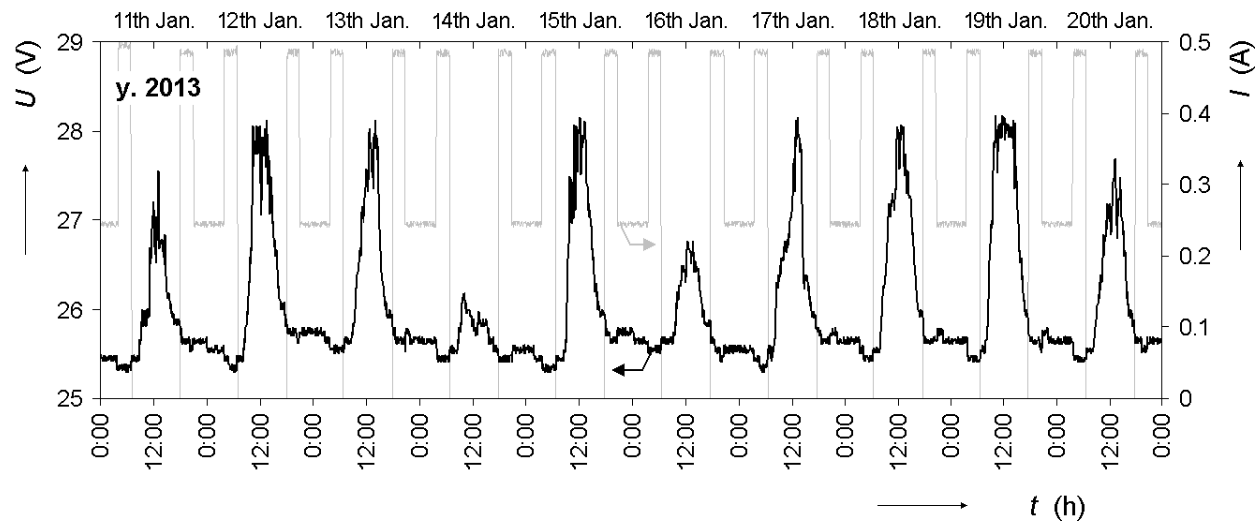

Fig. 3. Dependences of the batteries voltage and electric current cross the light source on the time during selected winter days

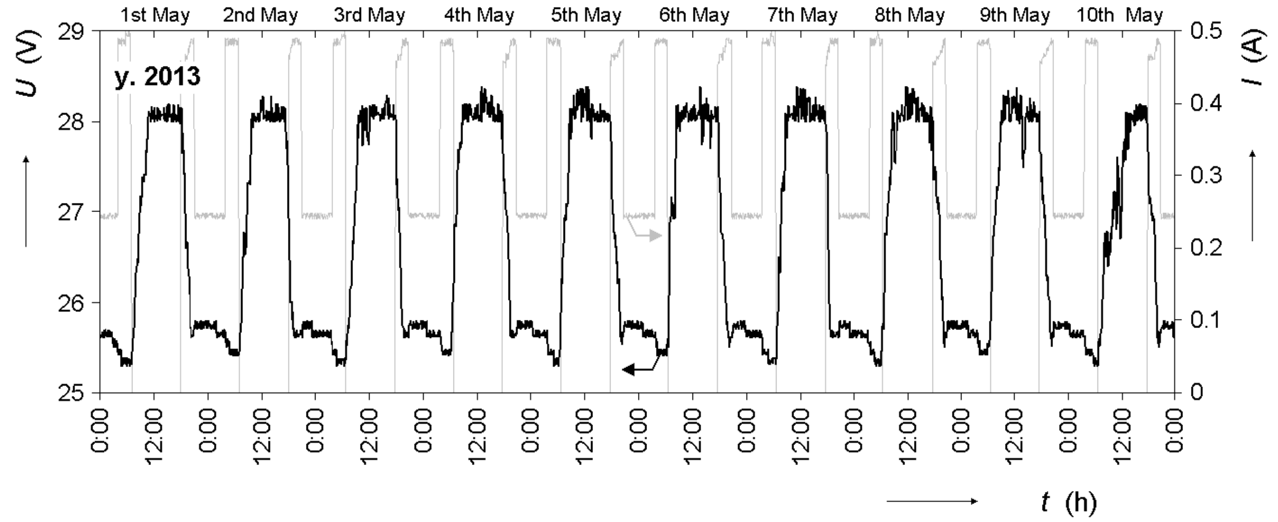

Fig. 4. Dependences of the batteries voltage and electric current cross the light source on the time during selected spring days

Conclusion

We have constructed the above mentioned off-grid PV system for illumination. The testing was started in the spring 2011. The PV system was self-sufficient till the 3rd November 2011. So since the November we modified the illumination mode. The illumination intensity was lowered, the discharging speed was decreased. After the optimization of the operating mode, the off-grid PV system was operating reliably during whole next years.

Based on our calculations and real measured data was then gradually modified mode of operation so that the PV system was then self-sustaining after two years and continues to work reliably. Of the three operation optimization options above we chose the decrease in radiation intensity of the light source, this option was considered the best in terms of the ratio between the price of the system and its parameters. Stated objective was reached from our point of view.

But in the future the batteries will degrade gradually reducing their capacity substantially within a few years so we will need to either re-adjust the lighting mode or replace the batteries. The operation life of lead-acid batteries is about 5 years. We will continue to collect the data and on that basis we will formulate further conclusions.

Similar off-grid PV system was tested and described for example in the reference (Sağlam S., et al., 2010).

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POSSIBILITY OF ENERGY EFFICIENCY INCREASING IN AGRICULTURE SECTOR OF UKRAINE

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In the paper the main idea is creating the measures for reducing energy consumption in the agricultural sector. For this porpoise the maps for distribution of tractors and combines enterprises with different areas will be developed.
***Keywords**: agricultural sector, transport, energy efficiency.*

Overview of Ukrainian Agricultural Sector. The agricultural sector of Ukraine accounts for about 10% of the country's GDP and provides the population with 95% of its food one of the highest rates in the world. In addition, the agricultural products market of Ukraine has vast potential to increase though exports. The sector becomes even more attractive taking into consideration the rapid growth of food prices in 2010-2011in the world as a whole and in Ukraine in particular. However, in the middle of the 2000s the agricultural sector became more attractive for the new modernized companies and huge holding companies with vertical integration. For the last 4-5 years the investment attractiveness of the agricultural sector of Ukraine grew several folds. During the "crisis" 2009 year, the agricultural sector was Ukraine's only economic sector that showed growth (+0.1% in production volume). In 2008 the capital investments to the sector achieved the record amount of 3.2 billion USD [1-3].

Retrospectives data of agricultural machinery. According to different estimates and expert opinions, 60 to 80% of agricultural machinery is available worn out, and ineffective use of such equipment increases the cost of production and grown resulting in greater losses at harvest. Data on availability of agricultural machinery enterprises owned presented in Tables 9 and Table 10. It should also be noted that the actual number of pieces of equipment is higher (10-15%). This is because of the technology when purchasing registered to an individual - the owner of the company, as well as the fact that the survey did not include data on the availability of appliances for enterprises that operations in several areas, so this technique was not included in the sample statistics that is presented in the table. The data presented in Figure 1 and Figure 2 to 21 142 enterprises (ie, about 50% of companies owned / report the availability of technology, while only 28% of sowing areas of up to 50 ha are owned / report on the availability of agricultural machinery. Nearly 91 % of squares with 1-3 thousand ha are available / report the availability of agricultural machinery. Sown area companies that reported the presence of agricultural machinery accounted for almost 85% of sown areas of all enterprises. The largest number of registered agricultural machinery in Vinnytsia, Dnipropetrovsk, Kirovohrad, Odessa, Poltava regions. According to the Derzhkomstat (State Comittee of Statistical Data) [4, 5] 01.01.2008, in Ukraine there were more than 41 thousand grain cars. At present (2013), worn-out fleet of combine harvesters is over 80%, that for the last ten years, domestic manufacturers produced a small amount of the total harvesting machines operated in Ukraine.

Baseline Calculation of Fuel Consumption. Baseline energy consumption is calculated as average consumption of Gasoil (Diesel), which issued only for transportation; it does not include transformation into other energy resources. Energy consumption for the last six years is presented based on the Fuel-Energy Study Books of the State Statistical Service in thousand tons of oil equivalent (toe) [1, 6, 7]..

Table 1. Diesel consumption during 2006-2011

Year	2006	2007	2008	2009	2010	2011
Diesel consumption, thousand toe	1 190	1 192	1 242	1 182	1 245	1 244

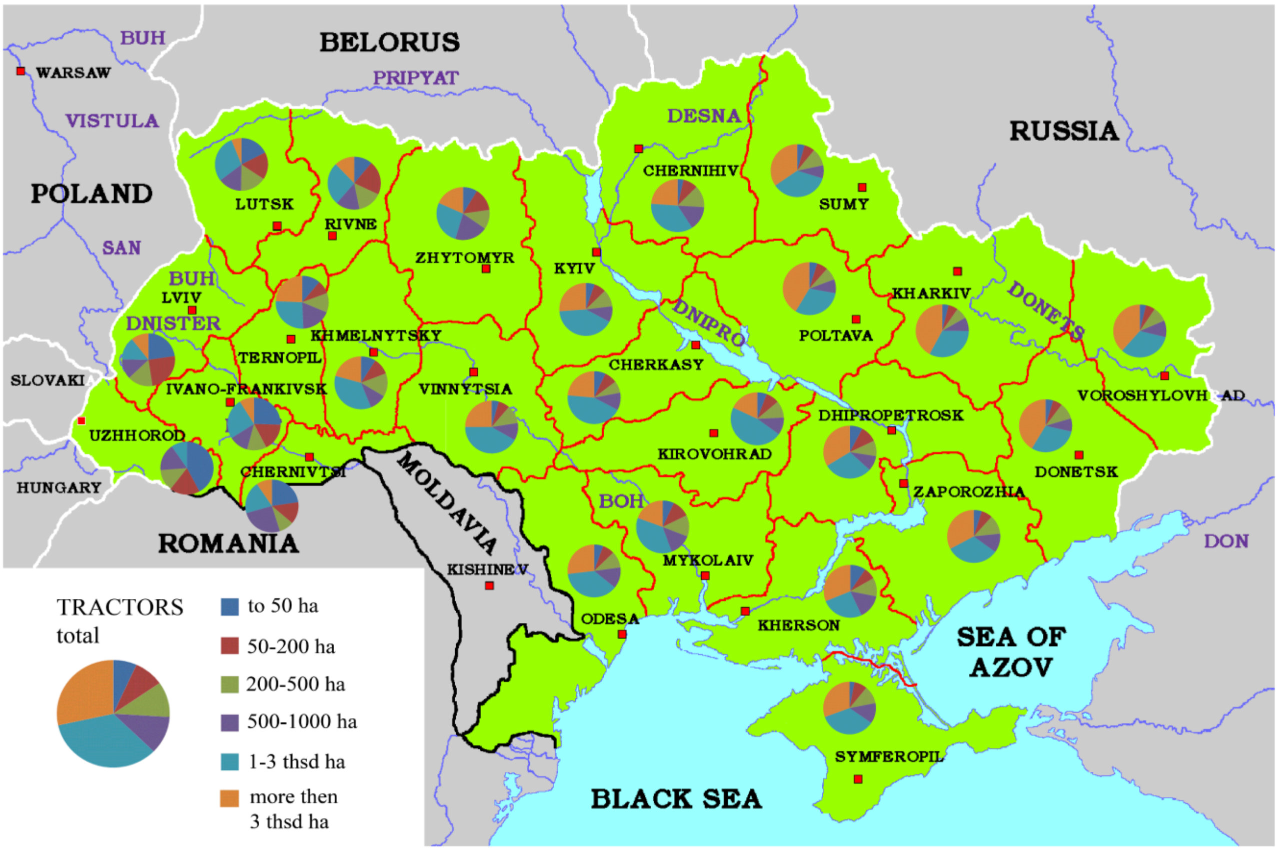

Fig. 1. Tractors 01.01.2012 according to different agricultural enterprises

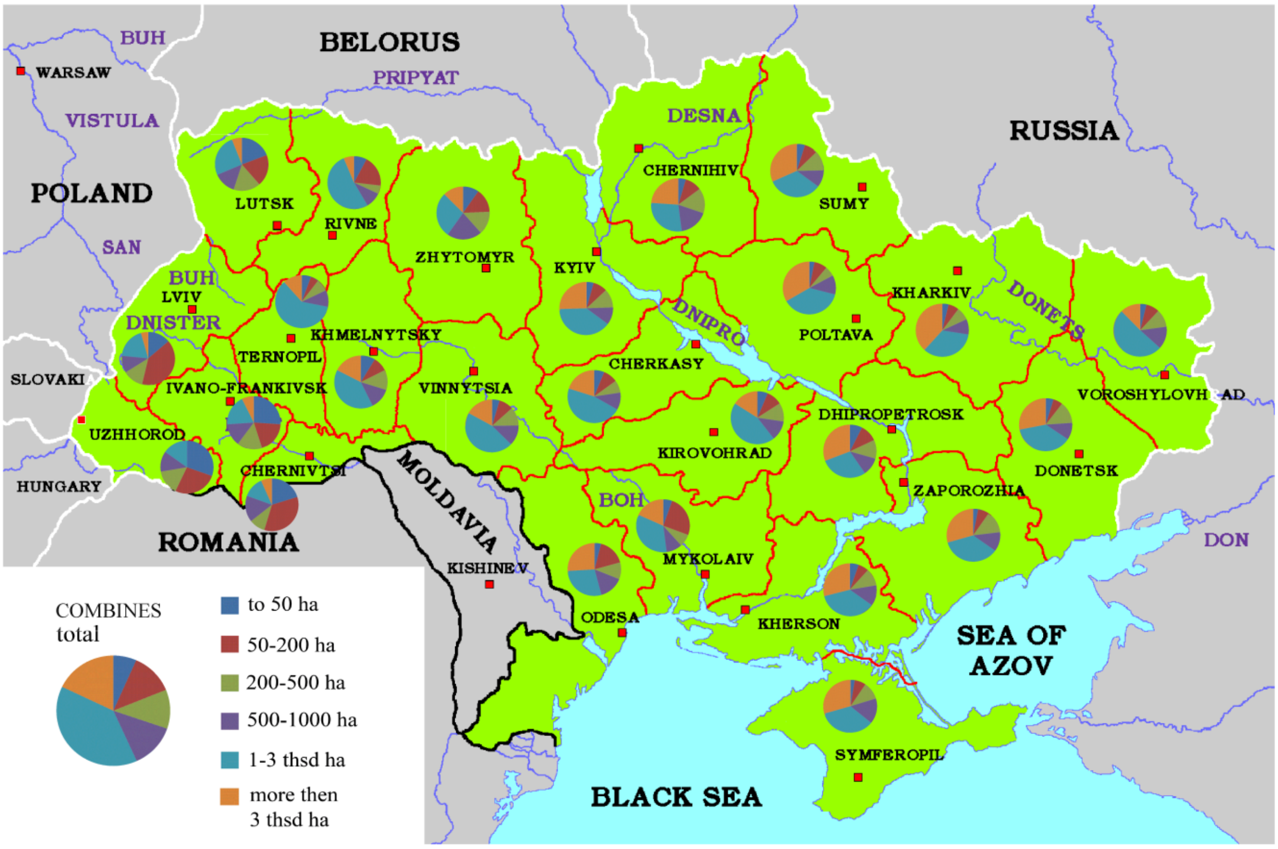

Fig. 2. Combine harvesters 01.01.2012 according to different agricultural enterprises

As seen in the table, diesel consumption has not changed significantly during the last four years, despite the influence of the crisis 2009 year. Reasonable baseline energy consumption could thus be the average level at 2008, 2010 and 2011 – or approximately 1 244 thousand toe.

It is difficult to estimate the baseline consumption for each type of machinery and equipment used in the agricultural sector, due to following factors [1]:

1. Wide variety of equipment models and manufacturers.
2. Varying rates of fuel consumption depending on the type of ground, its humidity, and working depth under tilling process.
3. Varying operational regimes of machinery.
4. Differences in maintenance of equipment.

Measures for Reducing Energy Consumption of Agricultural Machinery

Agricultural Technologies and Operations. Energy consumption during tillage is a strong function of the amount of earth that is moved. Traditional moldboard plows used in Ukraine are the most energy-intensive type of tillage equipment. Chisel plows and heavy offset disks result in moderate energy use as they move less earth and achieve shallower tillage than moldboard plows.

One of the main measures that could significantly decrease the energy consumption of the agricultural sector is changing from these intensive cropping technologies to no-till or mini-till technologies. According to “Agromir” calculations, in the case of spring barley growing, traditional technology results in the consumption of nearly 59.2 liters of diesel per hectare; in contrast, no-till technology is estimated to use approximately 22.8 liters of diesel per hectare [1, 8]. By using this technology, the agricultural sector could reduce diesel use by more than 60%.

Other survey on using mini-till technology was carried out by “Agro-Soyuz”, which achieved significant decreases in the consumption of fuel and lubricants (from 94 l/ha to 24 l/ha) and increases in grain production (from 2.4 t/ha to 5 t/ha) by changing to mini-till technology [1, 9]. It should be noted, however, that transferring to no-till or mini-till technology requires significantly increased fertilizer usage in the first few years. Another important measure for reducing energy consumption is the implementation of operational and energy management systems, which prescribe careful use of existing machinery and equipment in accordance with the following principals [1]:

- Using appropriate machinery for a given task. Tractors are more efficient when used near capacity. If possible, it is desirable to use a smaller tractor for operation requiring a lighter load. If not, a larger tractor can be used efficiently on smaller jobs by shifting to higher gears.
- Preventive maintenance and careful operation of tractors.
- Correct usage of the tractors’ ballast.
- Optimization of traffic patterns on the field and combining operations to reduce trips over the field.

Improving Energy Efficiency and Operation of Machinery. Recommended measures for improving efficiency and operation of machinery include [1]:

- *Reducing greenhouse gas emissions of the engine using SC systems*. Selective catalytic reduction (SCR) is a means of converting NO_x with the aid of a catalyst into diatomic nitrogen, N_2 and water.
- *Using Continuously Variable Transmissions instead of hydro mechanical transmissions*. This could increase transmission efficiency by 1.5-2 times and reduce energy consumption of the tractors by 30% in comparison with similar tractors [10].
- *Using electronic control units for rational control of transmission, engine and motor-to-gear ratio*.
- *Using alternative fuels*. Usage of LPG instead of diesel as a fuel will decrease CO_2 emissions by 60% and aromatic hydrocarbons by 40%.Another potential avenue for using alternative fuels could be through newly developed equipment technologies, such as the New Holland NH2 tractor, which uses hydrogen as a fuel.[11]

Conclusions. In this paper the maps for tractors and combines has developed with depicting the distribution of their amounts for enterprises with different areas. Measures for reducing energy consumption in the agricultural sector were presented.

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LIGHT-EMITTING DIODE SYSTEM FOR MERISTEMATIC PLANTS RADIATION

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The object of the study are LED irradiation facilities used for growing plants in greenhouses.
The aim is to increase the efficiency of LED irradiators. The characteristics of LEDs, said the advantages and disadvantages of these sources of exposure. The main advantage, which is the ability to adjust the intensity of the total luminous flux, and the change in spectral composition, by adjusting the intensity of the LED radiation in various light ranges. LED systems: high luminous efficiency with the ability to control the spectral composition of light sources and low power consumption.
Keywords: *Radiation, range, LED, intensity, efficiency.*

Leaves is the main plant organ absorbing and converting emission. Leaves' absorption of radiation is measured by their spectral composition as well as their own properties, i.e. thickness, the inner composition, the surface condition, the composition and pigment concentration. Due to the light emission power absorbed by leaves we can see all essential physiological processes occurring in them like photosynthesis, formation of various physiologically active substances, etc. The plant utilizes the power accumulated as a result of photosynthesis in all life cycle processes [1].

Absorption spectra of different plant species have been studied quite well. They all have similar characteristics. The plant leaf mainly absorbs visible and ultraviolet radiation with a wave length from 300 up to 750 nm. Emissions with a wave length from 600 up to 680 nm (an orange-red area) and 400-500 nm are usually absorbed to the full extent. Visible emissions with a wave length from 500-600 nm (a green-yellow area) are less absorbed.

Emissions within 380 -720 nm wave length are called photosynthetically active radiation (PAR).A green solitary plant leaf absorbs 80- 90% of photosynthetically active radiation and reflects 5-10% of it and transmits nearly the same amount. And 500-600 nm wave length emissions make up the major proportion of absorbed and transmitted radiation.

Optical emission impact on the plant is really essential. A great variety of optical emission impacts on plants can be divided into two types: power producing and regulatory. The typical examples of regulatory impact on plants are photomorphogenesis, phototropism and photoperiodism. Photosynthetic and heat impacts can be found in power producing ones. It needs power ten or hundred times as much for energy impact as compared to photoregulatory. The plant is impacted only by the proportion of radiation energy which is absorbed by it. For each photosynthesis process of plants there are photoreceptors which absorb radiation. For example, chlorophyll and carotinoids are responsible for photosynthesis process, and phytochromes – for photomorphogenesis [2].

The basic quantity of absorbed optical emission energy is converted into the heat in plants and partially transformed in the course of photosynthesis into intensity of the chemical compounds of organic matters. The proportion of the emission spectrum utilized in the photosynthesis process is unhomogeneous. This subspectrum is of vital importance in non natural radiation. The converted into heat the part of energy can be considered as a direct loss at first sight. But this part of the power heats the plant itself, the temperature of which can greatly exceed the surrounding air temperature. The photosynthetic rate depends on the temperature of photosynthetic organisms, so the heat impact of optical emission indirectly affects utilization of its energy in the photosynthesis process. The emission estimation in terms of the heat impact is of great practical importance if regarding the correlation between radiation and the temperature of surrounding air.

While using artificial radiation for photoregulatory exposures the spectral composition of radiation as well as daily duration and rate of frequency of radiation are of crucial importance [3].

Narrow-band light sources – light emitting semi-conductor diodes have widely spread in recent years. Modern LEDs overlap the whole visible range of light spectrum: from red to violet. The wavelength range of light emitting diodes radiation in red amounts to 620-630 nm; in orange – from 610 to 620 nm; in yellow – from 585 to 595 nm; in green – 520-535 nm; in blue – from 465 to 475 nm and in indigo – from 450 to 465 nm [4]. While using irradiation facilities with diverse LEDs in spectrum for greenhouse in plant breeding there is the possibility to control irradiation facility spectra in terms of photosynthetically active radiation (PAR). It's also possible to control the radiation intensity [5].

Regarding light-emitting diodes (LEDs) properties the light-emitting diode system for meristematic plants radiation was made at the department of Automatic Electric Drive in the Izhevsk State Agricultural Academy (fig.1).

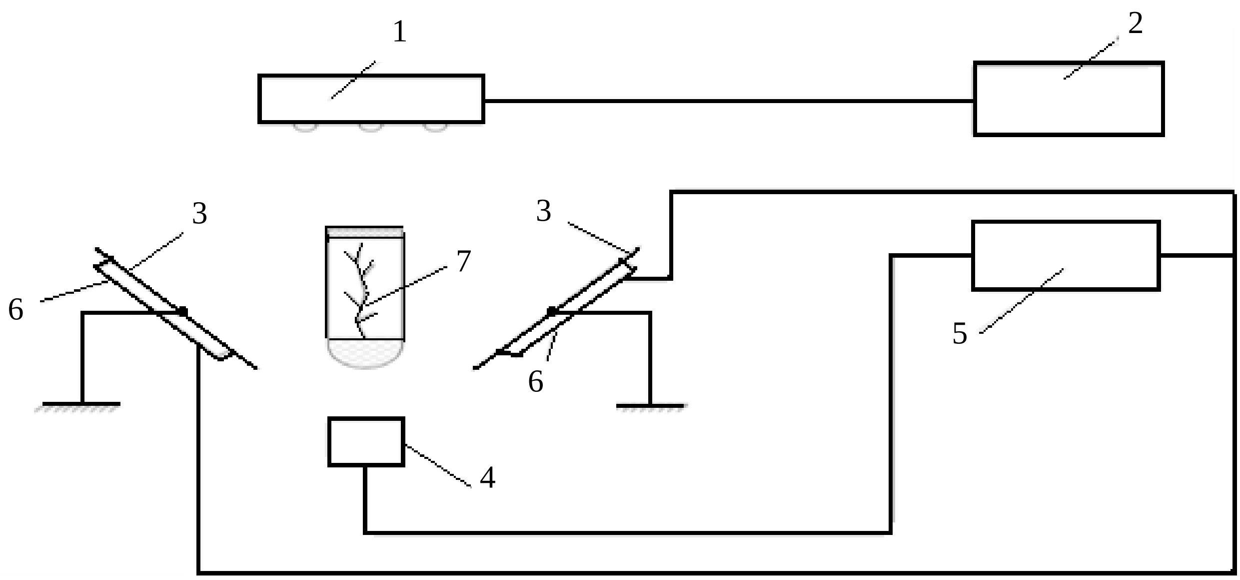

Fig. 1. Light-emitting diode system for meristematic plants

This system contains light-emitting diodes (1) in indigo / blue, red and white spectrum emission mounted in the lighting fixture, for example; the control power-supply unit (2), from which the voltage is applied to emitting diodes (1), front-projection screens (3), located along the plant row, suitable to alter the angle variation due to a flexible joint, temperature sensor (4), mounted in the plant growing area, temperature regulator (5), with its outlet plugged to the heating elements (6), located on front-projection screens, test tubes with plants (7) [6].

This system for meristematic plants radiation works as follows:

The voltage is supplied from the control power-supply unit (2) to LEDs (1) in different spectra emissions – red, indigo and white spectra which irradiate plants. Emission intensity and spectrum-correlation in red, white and indigo/ blue are set by the control power-supply unit (2). The fraction of the light flux from the diodes (1) reflecting from front-projection screens (3) irradiates additionally plants surface (7) in the given emission spectrum. To optimize the irradiation intensity of various species of plants the slope angle of the front-projection screens can be altered by the flexible joint. The signal from the temperature sensor (4) located in the plant growing area, comes to the temperature regulator (5) which controls the heating elements (6) located on the front-project screens (3) thus maintaining necessary temperature in the plant growing area.

The experiments carried out on the model of this system showed that the use of the LEDs system for meristematic plants irradiation can result in plant biometrics improvement by 12-15%.

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LIGHT VELOCITY IN CONSTANCY
(Investigation of monochromatic light bundles propagation of natural light in the atmospheric air continuum)

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In 1994 D.Kh.Baziyev's book "Basis of the uniform theory of physics" [M., «Pedagogics», 640 p.], in which the structure of an elementary beam of natural light was described and the equation for the velocityof monochromatic beams of light propagation in the environment of atmospheric air were given. This article is based on results of the experiment made by the author on measurement of velocity of propagation of the monochromatic beams of light which have confirmed a correctness of the equation for velocity of light.

The propagation velocity of the light in the vacuum c_0 = 2.9979246·10^8m/s is not a fundamental constant, the same for all kinds of radiation as it has been perceived before.

The velocity c_0 is the propagation velocity of only violet beams in the vacuum with photon step of λ = 400 nm according to the derived formula has the following refined value of c_0 =μ/4·10^{-7}m/s = const.

Keywords: *Velocity of light, photon, electrino, sectorial speed of a photon, charge and mass of an electrino, second energy of a beam, photon step, wave length, frequency.*

The recent achievements of fundamental physics

It was suggested in *The Fundamentals of Unified Theory of Physics* [1] that the velocity of light propagation is not a fundamental constant because the velocities of beam lets making up the white light are the function of wavelengths $c_i=f(\lambda,\nu)$, which can be described with the following formulae:

$$c_i = \sqrt{\mu \cdot \nu_i} = \mu/\lambda_i \text{ - for vacuum} \quad (1)$$

$$c_i = \mu/\lambda_i \cdot n_i \text{ - for atmospheric air,} \quad (2)$$

Where μ= 119.916 984 m^2/s is Milliken constant representing the photon sector velocity in the electric field of axial charge of the beam; and $n_i$is an index of air refraction for the monochromatic beam with wavelength λ_i under investigation.

It should be noted here that the index of air refraction for the beams with different wavelengths from λ=400 *nm* to λ=1200 *nm* changes insignificantly and is in the range from *n* = 1.0002982 (for violet rays) to *n* = 1.0002886 (for infrared ones) [3] and this allows to measure the velocity of propagation of monochromatic beams in the atmospheric air.

It is known since Newton that the white light consists of beam lets with different wavelengths covering the spectral range from 400 *nm* to 750 *nm*. It was shown within Unified Theory of Physics [1] that the light propagation velocity is attributable only to the violet part of the white light beam which is the beam front because the bundle of rays becomes reshaped on the way from start to finish where the receiving equipment is located and the violet beams, the most short-wave ones with the wavelength of λ= 400 *nm*, reach the finish first, while the red beams with wavelength λ= 750 *nm* are the last to come. That can be confirmed by solving formula (2):

$$c_1 = \mu/\lambda_1 \cdot n_1 = \frac{119.916984\ m^2/s}{4 \cdot 10^{-7} m \cdot 1.0002982} = 2.997030885 \cdot 10^8\ m/s \quad (3)$$

– violet beam velocity in the atmospheric air

$$c_2 = \mu/\lambda_2 \cdot n_2 = \frac{119.916984 m^2/s}{7.5 \cdot 10^{-7} \cdot 1.00029035} = 1.598429016 \cdot 10^8\ m/s \quad (4)$$

– red beam velocity in the atmospheric air.

The theoretical results derived from the new physics theory prove that violet beams propagate faster than the red ones by a factor of $k = c_1/c_2 = 1.874985$ times!

Since 1973 when CODATA (Committee on Data for Science and Technology) General Assembly decision on numerical value for the light propagation velocity in vacuum of $c_0=2.99792458\cdot10^8$ *m/s* was made up the scientific community has been in the state of self- complacency concerning this problem. But if one analyses the new results received both theoretically and experimentally, one can see the light velocity is not the fundamental constant though it has been used as such until now preventing further studying of the light properties and characteristics. In order to prove or disprove our results we carried out experimental measure of the propagation velocity of natural light monochromatic beams in the atmospheric air in the spectral range of 300 *nm* to 1200 *nm*. At first we took into consideration a few aspects. The first aspect is that according to the *Unified Theory of Physics* the natural light beam structure essentially differs from the laser beam structure owing to the difference of their propagation velocities coming up to 3.4%. The velocity of the laser and/or radar beam radiation is υ_0= 2.899*m/s* and it depends neither on wavelength nor on oscillation frequency because the laser beam propagation velocity depends only upon the charge of the axial field [1, p. 389-397].

The second aspect concerns the light structure and the structure material of the light. Existent point of view which alleges that light is an electromagnetic wave does not stand up to criticism because it contradicts to the most important property of the light, the energy, which the light owns and carries. The problem is that within current theory both electric field, and magnetic one have no structure as they have no material particles, they have no mass and therefore they cannot be energy carriers because the energy dimensionality cannot be expressed in Joule without a body with finite mass m_i.

$$E_i = \frac{m_i v_i^2}{2} = m_i v_i u_i = m_i v_i^2 \cdot \tau_i \cdot \nu_{unit},\ J \qquad (5)$$

where v_i and u_i are velocities of the body with mass m_i, τ_i is duration of movement of the body, and $\nu_{unit} = 1 \cdot s^{-1}$ is an interaction act of a body with a source of force according to the first Newton law.

But beyond all doubt the light carries the energyand therefore it consists of photons possessing finite mass and it is not the electromagnetic wave! This statement was proved in the experiment carried out at N.S.Kurnakov General Chemistry and Inorganic Chemistry Institute, Moscow, in 1999-2000 and the experiment was described in *The Charge and Mass of Photon* [2]. Therewith we took into consideration a new elementary particle named *electrino* ε derived from the formula for Plank constant [1, p. 17].

$$h = m_\varepsilon \cdot \mu \cdot \frac{\sqrt[3]{4\pi/3}}{2} =$$
$$= 6.62626810000 \cdot 10^{-34} kg \cdot \frac{m^2}{s} = const\,, \qquad (6)$$

where $m_\varepsilon = 6.85575729963 \cdot 10^{-36} kg = const$ is electrino mass, and μ is Milliken constant.

We asserted that the well-known M.Plank formula

$$E_i = hf_i,\ J \qquad (7)$$

Shows *second energy* (the conception introduced by the author and described as the energy of the elementary beam with wavelength λ_i which is carried by the beam during a second) of gas and fluid oscillators, where f_i is interaction frequency of the test oscillator in the medium. Another constant called Hertz constant was derived from Plank constant

$$\hbar = \frac{h}{\sqrt[3]{\frac{4\pi}{3}}} =$$
$$= 4.11060869204 \cdot 10^{-34} kg \cdot \frac{m^2}{s} = const \qquad (8)$$

It is Hertz constant that can be applied to calculation of the *second energy* of a natural light elementary beam, E_i:

$$E_i = \hbar \cdot \nu_i = \hbar \cdot \frac{\mu}{\lambda_i^2}, J \qquad (9)$$

where ν_i= is photon frequency along the beam axis, and λ_i is the wavelength of that beam expressed in metres. To show clearly the essence of these solutions let's consider the *second energy* of a single beam coming from the sun with wavelength of λ_1 = 4· 10^{-7}*m* (violet beam).

$$\nu_1 = \mu/\lambda_1^2 = \frac{119.3916984\ m^2/s^{-1}}{1.6\cdot10^{-13} m^2} = 7.4948115 \cdot 10^{14} s^{-1} \qquad (10)$$

is the violet beam frequency, and the *second energy* of the violet beam is

$$E_1 = \hbar \cdot \nu_1 = 3.08082372971 \cdot 10^{-19} J. \qquad (11)$$

According to our new theory of physics the photon simultaneously possesses two kinds of movement because it moves along the beam axis with semi-circular steps and every step of it regardless of its wavelength makes up angle of γ = 4 *rad* therewith the velocity of the beam propagation c_i in the space and *electrino* orbital velocity u_i are bound with the following relationship:

$$u_i = 2c_i = 2\mu/\lambda_i, J \quad (12)$$

and this allows to calculate the mechanical energy of the violet beam without using frequency and Hertz constant

$$E_1 = \frac{m_\varepsilon \cdot c_1 \cdot u_i}{\gamma} = \frac{m_\varepsilon \cdot c_1 \cdot 2c_1}{4} = \frac{m_\varepsilon \cdot c_1^2}{2} = \frac{6.85573729963 \cdot 10^{-36} kg \cdot (2.9979246 \cdot 10^8 m/s)^2}{2} =$$
$$=3.08082372971 \cdot 10^{-19} J. \quad (13)$$

Complete coincidence of the values of the *second energy* for the violet single beam received by formulae (11) and (13) disproves the current idea about light as an electromagnetic wave and it proves the truth of Newton's conception who asserted as far back as in 1687 that the light consisted of corpuscles though at that time his assertions remained without proving.

Considering light structure and its generation we discovered the true picture of the energy basis of the light beam founded upon the interaction of *electrino* positive charge $\varepsilon = 1.98766431671 \cdot 10^{-27} C$ (Coulomb) with the negative and equal in absolute value to the *electrino* positive charge of the beam axis field $-\varepsilon$. Now we can calculate the *second energy* of the violet beam by the third way:

$$E_1 = \frac{\alpha \cdot \varepsilon \cdot q}{\nu_{unit}} \cdot \nu_1 = \frac{\alpha \cdot \varepsilon \cdot q \cdot \mu}{\nu_{unit} \cdot \lambda_1^2} =$$
$$= 3.08082372971 \cdot 10^{-19} J, \quad (14)$$

where $\alpha = 1.04044721942 \cdot 10^{20} J/C$ = const is an electro-dynamic constant of *Unified Theory of Physics*, $q = -\varepsilon = -1.98766431671 \cdot 10^{-27} C$. In (14) the minus sign appears naturally in front of the beam energy value and it testifies that the *electrino* movement acting as a photon takes place around the center of force along the second-order trajectory and that makes constant the photon sector velocity:

$$\mu = u_1 \cdot r_1 = 2c_1 \cdot \frac{\lambda_1}{2} = c_1 \cdot \lambda_1 =$$
$$= 119.916984 m^2/s = const \quad (15)$$

where $r_1 = \lambda_1/2$ is orbital radius of the violet beam photon, $c_1 = c_0$ is the velocity of this beam in vacuum, $\lambda = 4 \cdot 10^{-7} m$ is the beam photon step. Both these values have been determined with direct measurements long ago.

Therefore we can make an important assumption that not the light propagation velocity in vacuum, but the photon sector velocity, the same for all the spectrum of the natural light is the fundamental constant in the light structure.

The following conclusions can be derived from the above-stated:

1. Studying the physical essence of Plank constant and the second truly elementary particle, the *electrino*, which we have found and which exists in the nature together with the first elementary particle, electron, allows to explain the charge symmetry in the atom structure, because that particle possesses an elementary positive charge and it is the charge counter-balance for the electron.

2. The *electrino* is a magnetic field carrier, it also carries electric current, it is a photon in all kinds of radiations, it plays the role of neutrino while travelling along the first-order trajectory and it has the movement velocity of $\upsilon_\nu = 10^{20} - 10^{30} m/s$ in the interstellar space.

3. The *electrino* charge share in the atom structure is 50% and it makes up 99.83% of its mass for all the physical bodies starting from the elementary atom with mass of $m_u = 1/12(^{12}C) = 1.66057 \cdot 10^{27} kg$ to uranium atom and to all the other physical bodies.

Experimental technique

Experimental facility shown in Fig. 1 was produced in order to verify theoretical conclusions where the complex white light from the high pressure mercury lamp DRSh-500 with power of 500*Wt* propagates from point S as an expending beam to the collecting lens located at the distance of *2f = 13.062 m* (*f = 6.531m* is the lens focal distance), the bundle of rays from the lens comes to the rotating mirror at point A and focuses in it. The mirror was made up of two parts. The plane of the mirror lower part with the sizes of $2 \times 2m^2$ is parallel to the mirror rotation axis, and the upper one also with the sizes of $2 \times 2m^2$ is inclined to the rotation axis at the angle of $\beta = 1° 22'$. The experimental set was fastened on the shaft of a direct-current electric motor MA-30M, with the power of 95 *Wt* (*i* =3.6 *A* and *V* = 27*V*).

When the experimental set rotates, the ray bundle under the investigation starts from the lower mirror and widening comes to the first spherical mirror with radius of curvature of R_1 = =22.9 *m* (Fig.1) at point B. The reflected bundle turns to the plane mirror C where it focuses. From the plane mirror the diverging bundle directs to the second spherical mirror with radius curvature of R_2 = 26.27 *m* at point D, then it comes back to the rotating mirror, finishes on its upper part, and it is diverged to the screen at point A_1 at the distance of R = 7.2 m from the rotating mirror where it focuses again. The total path length from the starting point to the finish is L = 89.10 *m*. When maintaining voltage level of the electric motor at 29±*0.25V*the mirror average rotation speed was $\bar{n}$ =12831.05 *revolutions per minute* = 213.850833 *revolutions per second* and its maximum value (51408/4 = 21852 *revolutions per minute*) differed from average one by value $\Delta n = n_{max} - \bar{n} = 20.95$ *revolutions per minute.* It is one 0.001932thof the average value and this instability is of little significance in the experiment.

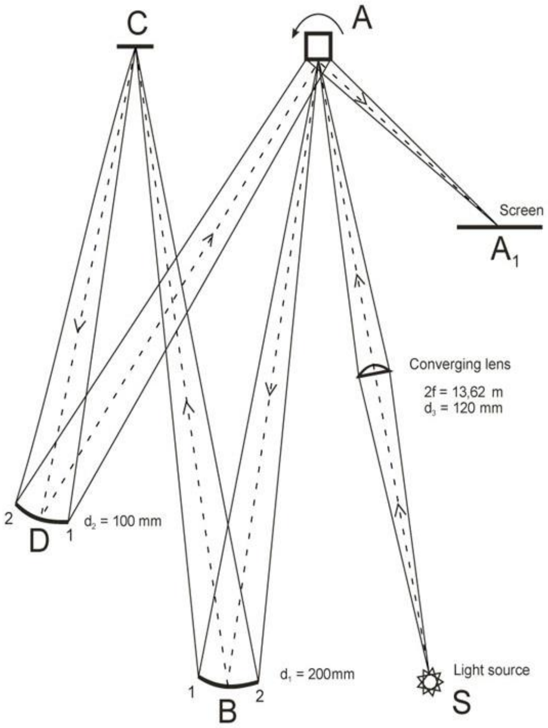

Fig.1. Scheme of optical system:
S – light source, mercury lamp, W = 500 watt,
AB = 22.9 *m*, distance between the rotating mirror (A)and the 1st spherical mirror,
BC = 25.55 *m*, distance between the 1st spherical mirror and the plane mirror (C)

A massive table on three legs was set at point A where a photographic camera without lens and with remote shutter control was fastened.

The essence of the experiment turns to photographic fixation of the tracks of the monochromatic beams left by them on photographic emulsion of the commercial coloured film with sensitivity of 400 units. A thin celluloid film was located before the camera. There were vertical strips at the distance of $a = 5$ *mm* from each other on the celluloid film and they were used to create a graticule on the photographic film. The graticule allowed to establish the enlargement factor k_i :

$$k_i = a_1/a, \qquad (16)$$

where$a_1$is the distance between the strips on the photographic picture, measured with the accuracy of one tenth of millimetre.

When the mirror does not rotate, it is possible to operate it by hand and to send the light bundle reflected from the upper part of the mirror through the photographic camera and then it is possible to have a continuous trace of the beam on the photographic film from the point of entry into the camera (defined point) to the exit of the beam from the camera with the length of l_i. But if the mirror rotates the track of bundle changes. Now it consists of two parts: one part is invisible because while the front of the light bundle passes the distance of l_i during the time τ_i , the rotating mirror manages to turn through some angle φ_i and the front of the bundle finishes when the angle of arrival at the mirror has changed and so the front of the bundle deflects from the defined point to the left by the distance of Δl_i which represents the invisible disappeared part of the track defining the beam retardation time. The other visible part of the track represents real influence of the light upon photoemulsion of the photographic film and the trace of this influence can be easily measured on the photograph.

It is quite clearly that the deviation of the beam from the defined point is a function of the velocity of beam propagation while all the other conditions are not changed. So if the old point of view is true and c_0 is the fundamental constant, the same for all kinds of radiation, we should get the same deviation Δl and the same length of the visible track for all monochromatic bundles under investigation.

And vice versa, if we receive tracks of several monochromatic beams clearly distinguished from one to another, but correlated with the wavelength, we can come to the conclusion that the idea of c_o as a fundamental constant is unfounded and it is necessary to review the whole prevailing theory of physics created in the 20s of the 20th century which is the foundation of metrology.

Air-refractive index as a function of path length of the light beam

Initial data for analysis

n_{air}= 1.0002918 is index of refraction at ground air at t = 20°C and P_0 = 101325 *Pa* [3, p. 138] n_1= 1.0002827 is air-refractive index at the same conditions for the monochromatic bundle of violet beams with wavelength of $\lambda_1 = 4{\cdot}10^{-7}m$(the leading edge of the visible part of the sunlight spectre).

n_2= 1.0002802 is air-refractive index of blue monochromatic beam with wavelength of $\lambda_2 = 4.6{\cdot}10^{-7}m$.

n_3= 1.0002778786 is index of refraction of the air (the conditions are the same) for monochromatic green ray beams with wavelength of λ_3 = 5.4607·10^{-7}m (the middle of the visible part of the spectre).

n_4= 1.00027524 is index of refraction of the air for monochromatic red ray bundle with wavelength of λ_4= 7.6·10^{-7}m (trailing edge of the spectre visible part).

$\Delta n = n_1 - n_4$ = 0.0000074 = the difference of air-refractive indexes for the beam leading edge and trailing edge of the visible part of light spectre.

Analysis data

It is accepted that the index of refraction for some medium transparent for the light is ratio of the velocity of light in vacuum c_o to its velocity in the medium being investigated, c_i:

$$n_i = c_0/c_i \quad (17)$$

However we have established that this formula is wrong because the velocity of light in vacuum c_0 is not the universal constant applicable for the whole frequency range of the natural light, it can be applied only for the light velocity of violet beams in vacuum with wave length of λ_1= 4 ·10^{-7}m according to formula (1)

$$c_o = \mu/\lambda_1 = \frac{119.916984 m^2/s}{4 \cdot 10^{-7} m} = 2.9979246 \cdot 10^8\, m/s = const. \quad (18)$$

The fact that c_0 is the constant value in vacuum can be confirmed by the followings: first, the distance between photons along the beam axis, that is λ_1, is a constant value, secondly, λ_1 keeps constant because there are neither photon dispersion nor photon absorption in the vacuum. But in the real medium the velocity of beam propagation can be described by another expression where $c_i$is always less than c_{0i} as the value of n_i is always more than 1 in all the real mediums:

$$c_i = \frac{\mu}{\lambda_i \cdot n_i} = \frac{c_{0i}}{n_i}, \quad (19)$$

where c_{0i} the velocity of i-th beam in the vacuum.

But a very important factor that is the length of the beam path L_i in the medium under investigation is absent in (19). This factor is very important because n_i is a continuous function of coordinates of the beam leading edge.

The index of refraction in the air and other gases can be measured with Jamin interferometer provided with two cells. The reference gas is in the first cell and the gas under investigation is in the second cell. As we could not find specific information about the length of the cell we supposed that it was l_{unit}= 1m. There with it should be taken into consideration that the wavelength of the beam while interacting with air molecules along the cell path l_{unit} can change because the beam wavelength is equal to λ_{0i} at the entrance into the cell and it is equal to λ_i at the exit when the beam frequency ν_i is equal to

$$\nu_i = \mu/\lambda_o^2 \cdot n_i^2 \ , \quad (20)$$

and that allows to come from the propagation velocity to the wavelength to define the index of refraction n_i:

$$n_i = \lambda_{1i}/\lambda_{0i}\ , \quad (21)$$

and further to the spatial coefficient of the refractive index k_n:

$$k_n = \frac{\lambda_i - \lambda_{0i}}{\lambda_{0i} \cdot l_{unit}}, m^{-1}\ . \quad (22)$$

It shows that in spite of existing views the light beam is not a simple electromagnetic wave but an electro-dynamic system, spreading in the space, with an axial negative field as its basis, and positive charged *electrinos* move along its axis with semi-circular steps. The step of an **electrino** is λ_i and this step represents the average distance between *electrinos* on the beam axis. If it happens that at least one *electrino*-photon leaves the beam, the whole beam rearranges instantly and the space left vacant equal to $\lambda_{0i}$is dispersed uniformly, and then the length of step in the beam gets new value $\lambda_i = \lambda_0 + \Delta\lambda$

$$c_i = \frac{\mu}{\left(\lambda_{0i} + \frac{n_i \cdot \lambda_{0i}}{k_i}\right)} = \frac{\mu}{\lambda_{0i} \cdot \left(1 + \frac{n_i}{k_i}\right)}\ , \quad (23)$$

where n_i is the number of photons which left the beam while moving through the cell.

Now taking into account the formulae (17) to (23) we should make quantitative analysis of dynamics of violet, blue, green and red beams while the beams propagate along the cell in Jamin interferometer.

Violet beam

λ_{01} = 4·10^{-7}m is the step length at the cell entrance,

$$\lambda_1 = 4 \cdot 10^{-7} m \cdot 1.0002827 = 4.0011308 \cdot 10^{-7} m \quad (24)$$

is the step length at the cell exit,

$$c_1 = \mu/\lambda_1 = \frac{119.916984m^2/s}{4.0011308 \cdot 10^{-7}m} = 2.99707732623 \cdot 10^8\, m/s \quad (25)$$

is the beam velocity at the cell exit,

$$k_o = {}^1\!/_{\lambda_{0t}} = 2.5 \cdot 10^6 m^{-1} \quad (26)$$

is the number of photons per running metre at the cell entrance,

$$k_1 = {}^1\!/_{\lambda_1} = 2.49929344974 \cdot 10^6 m^{-1} \quad (27)$$

is the number of photons at the beam section l_{unit}= 1m at the cell exit,

$$\Delta k_1 = k_0 - k_1 = 706.55026m^{-1} \quad (28)$$

is the number of photons dispersed from the beam by the air molecules while passing through the cell

$$k_{n1} = \frac{\lambda_1 - \lambda_{01}}{\lambda_{01} \cdot l_{unit}} = \frac{\lambda_{01}(n_1 - 1)}{l_{unit}} = \frac{0.0011308 \cdot 10^{-7}m}{4 \cdot 10^{-7}m^2} = = 2.827 \cdot 10^{-4} m^{-1} \quad (29)$$

is spatial refractive index,

$$n_1(L) = (n_1 + k_{n1} \cdot L) = 1.0002827 + 0.02518857 = = 1.025471127 \quad (30)$$

is air spatial refractive index at the path of L = 89.1m, which served as the experimental basis

$$c_1' = \mu/\lambda_{01} \cdot n_1(L) = \frac{\mu}{4.10188508 \cdot 10^{-7}} = 2.92346035203 \cdot 10^8\, m/s \quad (31)$$

is the velocity of violet beams at the end of path L,

$$\bar{c}_1 = \frac{c_{01} + c_1'}{2} = 2.96069247601 \cdot 10^8\, m/s \quad (32)$$

is the average velocity of the beam at the path L,

$$\tau_1 = L/\bar{c}_1 = \frac{89.1m}{\bar{c}_1} = 3.009431095 \cdot 10^{-7}s \quad (33)$$

is the retardation time of the violet beam on the path L = 89.1 m

$$\bar{\lambda}_1 = \mu/\bar{c}_1 = 4.0503019132 \cdot 10^{-7}m \quad (34)$$

is the average step of photon on the path L,

$$\bar{k}_1 = \frac{1}{\bar{\lambda}_1} = 2.46895175083 \cdot 10^6 m^{-1} \quad (35)$$

is the average linear density of photons on the path L, and

$$\Delta k_1(L) = k_0 - \bar{k}_1 = 31048.24917m^{-1} \quad (36)$$

is the number of photons dispersed from the violet beam by the air molecules on the path L.

It follows from (34) that while the beam passed just only the distance of 89.1 m, the photon step increased by 5.03% which is a very significant red shift.

Applying the found regularities we can assess, for example, what happens with the beam coming from the Sun to the Earth at the dawn and at the sunset glow when the beam passes $L_1 = 10^4 m$ along the Earth surface through the densest and most polluted atmospheric layer:

$$n_1(L_1) = n_1 + k_n \cdot 10^4 m = 3.8272827 \quad (37)$$

is air refractive index for violet beams while watching the morning dawn and the evening sunset glow.

$$\lambda_1' = \lambda_{01} \cdot n_1(L_1) = 15.3091308 \cdot 10^{-7}m \quad (38)$$

the violet beams come out of the visible spectre area and enter short-range infrared spectre area

$$c_1' = \mu/\lambda_1' = 7.833036739 \cdot 10^7\, m/s \quad (39)$$

is the velocity of violet beam propagation on leaving the air surface layer after passing the path L_1,

$$\bar{c}_1(L) = \frac{c_{01} - c_1''}{2} = = 1.890614137 \cdot 10^8\, m/s = 0.63 \cdot c_0 \quad (40)$$

is the average beam velocity while on the path L_1,

$$k(L_1) = \frac{1}{\lambda_1'} = 6.53204948774 \cdot 10^5 m^{-1} \quad (41)$$

is the linear density of photons along the beam while passing the path L_1,

$$\Delta k(L_1) = k_0 - k(L_1) = = 1.84679505123 \cdot 10^6 m^{-1}, \quad (42)$$

and

$$k_1(L_1) = \Delta k(L_1) \cdot L_1 = 1.84679505123 \cdot 10^{10}$$

is the total number of photons lost by the beam on the path L_1.

The calculations explain why the dawns and sunsets on our planet are always coloured with red and yellow tones. It becomes clear now that red shift coefficient all over the range of the sun spectre is far more for its short-wave part and is much less for its long-wave part.

Blue beam

$\lambda_{02} = 4.6 \cdot 10^{-7} m$ is the photon step length at the cell entrance,

n_2 = 1.0002802 is the refractive index [4, p.791],

$$\lambda_2 = \lambda_{02} \cdot n_2 = 4.60128892 \cdot 10^{-7} m \quad (43)$$

is the photon step at the cell exit,

$$c_{02} = \mu/\lambda_{02} = 2.60689095952 \cdot 10^8 m/s \quad (44)$$

is the beam velocity at the cell entrance

$$c_2=\mu/\lambda_2=2.60616071029\cdot10^8 m/s \quad (45)$$

is the beam velocity at the cell exit

$$k_0=\frac{1}{\lambda_{02}}=2.17391304347\cdot10^6 m^{-1} \quad (46)$$

is the linear density of photons at the cell entrance,

$$k_2=\frac{1}{\lambda_2}=2.173304083967\cdot10^6 m^{-1} \quad (47)$$

is the linear density of photons at the cell exit,

$$\Delta k_2=k_0-k_2=608.9598 m^{-1} \quad (48)$$

is the number of photons dispersed from the beam by the air molecules while passing through the cell

$$k_{n2}=\frac{\lambda_2-\lambda_{02}}{\lambda_{02}\cdot l_{unit}}=\frac{12.8892\cdot10^{-11}m}{4.6\cdot10^{-7}m^2}= = 2.802\cdot10^{-4}m^{-1} \quad (49)$$

is spatial refractive index,

$$n_2(L)=(n_2+k_{n2}\cdot L)= 1.02524602 \quad (50)$$

is air refractive index at the path of L = 89.1m,

$$\lambda_2(L)=\lambda_{02}\cdot n_2(L)=4.716131692\cdot10^{-7}m \quad (51)$$

is the photon step at the end of the path L,

$$\bar{\lambda}_2(L)=\frac{\lambda_2+\lambda_2(L)}{2}=4.658710306\cdot10^{-7}m \quad (52)$$

is the average photon step on the path,

$$\bar{c}_2=\mu/\bar{\lambda}(L)=2.57403822353\cdot10^8 m/s \quad (53)$$

is the average beam velocity on the path L,

$$\tau_2=L/\bar{c}_2=\frac{89.1m}{\bar{c}_2}=3.46148705895\cdot10^{-7}s \quad (54)$$

is the retardation time of the beam on the path L,

$$\bar{k}_2=\frac{1}{\bar{\lambda}_2(L)}=2.14651681327\cdot10^6 m^{-1} \quad (55)$$

is the average linear density of photons in the beam on the path L,

$$\Delta k_2(L)=k_0-\bar{k}_2=27396.2302 m^{-1} \quad (56)$$

is the average number of photons lost at each metre on the beam path, and

$$k_2(L)=\Delta k_2(L)\cdot L=2.44100411082\cdot10^6 \quad (57)$$

is total number of photons dispersed from the beam by the air molecules on path L.

Green beam

λ_{03} =5.4607·10^{-7} m is the photon step at the cell entrance,

$$\lambda_3=\lambda_{03}\cdot n_3=5.46221741167\cdot10^{-7} m \quad (58)$$

is the photon step at the cell exit,

$$c_{03}=\mu/\lambda_{03}=2.19600021975\cdot10^8 m/s \quad (59)$$

is the beam velocity at the cell entrance

$$c_3=\mu/\lambda_3=2.1953901678\cdot10^8 m/s \quad (60)$$

is the beam velocity at the cell exit

$$k_0=\frac{1}{\lambda_{03}}=1.83126705367\cdot10^6 m^{-1} \quad (61)$$

is the linear density of photons at the cell entrance,

$$k_3=\frac{1}{\lambda_3}=1.83075832511\cdot10^6 m^{-1} \quad (62)$$

is the linear density of photons at the cell exit,

$$\Delta k_3=k_0-k_3=508.72856 m^{-1} \quad (63)$$

is the number of photons cut off from the beam by the air molecules in the cell

$$k_{n3}=\frac{\lambda_3-\lambda_{03}}{\lambda_{03}\cdot l_{unit}}=\frac{15.1741167\cdot10^{-11}m}{5.4607\cdot10^{-7}m^2}= = 2.77878599823\cdot10^{-4}m^{-1} \quad (64)$$

is spatial refractive index for the green beam,

$$n_3(L)=n_3+k_{n3}\cdot L=1.02503686184 \quad (65)$$

is air refractive index at the path L,

$$\lambda_3(L)=\lambda_{03}\cdot n_3(L)=5.59741879144\cdot10\text{-}7 m \quad (66)$$

is the photon step at the end of the path L,

$$\bar{\lambda}_3(L)=\frac{\lambda_3+\lambda_3(L)}{2}=5.52981810155\cdot10^{-7}m \quad (67)$$

is the average photon step on the path L,

$$\bar{c}_3=\mu/\bar{\lambda}_3(L)=2.16855205357\cdot10^8 m/s \quad (68)$$

is the average beam velocity on the path L,

$$\tau_3=L/\bar{c}_3=4.10873236145\cdot10^{-7}s \quad (69)$$

is the retardation time of the beam on the path L,

$$\bar{k}_3=\frac{1}{\bar{\lambda}_3(L)}=1.80837774703\cdot10^6 m^{-1} \quad (70)$$

is the average linear density of photons in the beam on the path L,

$$\Delta k_3(L)=k_0-\bar{k}_3=22889.30664 m^{-1} \quad (71)$$

is the number of photons lost by the beam at the distance of one metre on the path, and

$$k_3(L)=\Delta k_3(L)=2.03943722162\cdot10^6 \quad (72)$$

is total number of photons lost by the beam on path L=89.1m.

Red beam

λ_{04} = 7.6·$10^{-7}m$ is the photon step at the cell entrance,

n_4 = 1.00027524 is the refractive index [4, p.791]

$$\lambda_4 = \lambda_{04} \cdot n_4 = 7.602091824 \cdot 10^{-7} m \quad (73)$$

is the photon step at the cell exit,

$$c_{04} = \mu / \lambda_{04} = 1.57785505263 \cdot 10^8 m/s \quad (74)$$

is the beam velocity at the cell entrance

$$c_4 = \mu / \lambda_4 = 1.5774208833 \cdot 10^8 m/s \quad (75)$$

is the beam velocity at the cell exit

$$k_0 = \frac{1}{\lambda_{04}} = 1.31578947368 \cdot 10^6 m^{-1} \quad (76)$$

is the linear density of photons at the cell entrance,

$$k_4 = \frac{1}{\lambda_4} = 1.31542741544 \cdot 10^6 m^{-1} \quad (77)$$

is the linear density of photons at the cell exit,

$$\Delta k_4 = k_0 - k_4 = 362.05824\ m^{-1} \quad (78)$$

is the number of photons dispersed out of the beam while passing through the cell,

$$k_{n4} = \frac{\lambda_4 - \lambda_{04}}{\lambda_{04} \cdot l_{unit}} = \frac{20.91824 \cdot 10^{-11} m}{7.6 \cdot 10^{-7} m^2} = = 2.7524 \cdot 10^{-4} m^{-1} \quad (79)$$

is spatial refractive index,

$$n_4(L) = n_4 + k_{n4} \cdot L = 1.024799124 \quad (80)$$

is air refractive index on the path L,

$$\lambda_4(L) = \lambda_{04} \cdot n_4(L) = 7.7884733424 \cdot 10^{-7}\ m \quad (81)$$

is the photon step at the end of the path L,

$$\bar{\lambda}_4(L) = \frac{\lambda_4 + \lambda_4(L)}{2} = 7.6952825832 \cdot 10^{-7} m \quad (82)$$

is the average photon step on the path,

$$\bar{c}_4 = \mu / \bar{\lambda}_4(L) = 1.55831813456 \cdot 10^8 m/s \quad (83)$$

is the average beam velocity on the path L,

$$\tau_4 = L / \bar{c}_4 = 5.71770282485 \cdot 10^{-7} \quad (84)$$

is the retardation time of the beam on the path L,

$$\bar{k}_4 = \frac{1}{\bar{\lambda}_4(L)} = 1{,}299\,497\,437\,79 \cdot 10^6\ м^{-1} \quad (85)$$

is the average linear density of photons on the path L,

$$\Delta k_4(L) = k_0 - \bar{k}_4 = 16292{,}03589\ м^{-1} \quad (86)$$

is the average number of photons lost by the beam at each metre on the path, and

$$k_4(L) = \Delta k_4(L) \cdot L = 1{,}451\,620\,397\,79 \cdot 10^6 \quad (87)$$

is total number of photons dispersed from the beam by the air molecules on the path L.

All the mentioned above represents the theoretical basis for the experiment set and carried out. In conclusion we offer the comparison data for some coefficients following from the considered theoretical material

$$\alpha_1 = \frac{c_1}{c_2} = \frac{2{,}997\,077\,326\,23 \cdot 10^8}{2{,}606\,160\,710\,29 \cdot 10^8} = 1{,}149\,997\,125\,81, \quad (88)$$

$$\alpha_2 = \frac{c_1}{c_3} = \frac{c_1}{2{,}195\,390\,1678 \cdot 10^8} = 1{,}365\,168\,4198, \quad (89)$$

$$\alpha_3 = \frac{c_1}{c_4} = \frac{c_1}{1{,}557\,420\,8833 \cdot 10^8} = 1{,}899\,985\,83, \quad (90)$$

$$\beta_1 = \frac{\lambda_4}{\lambda_1} = \frac{7{,}602\,091\,824 \cdot 10^{-7}}{4{,}0011308 \cdot 10^{-7}} = 1{,}899\,98583 = \alpha_3, \quad (91)$$

$$\beta_2 = \frac{\lambda_3}{\lambda_1} = \frac{5.46221741167 \cdot 10^{-7}}{\lambda_1} = = 1.3651684198 = \alpha_2 \quad (92)$$

$$\beta_3 = \frac{\lambda_2}{\lambda_1} = \frac{4{,}601\,288\,92 \cdot 10^{-7}}{\lambda_1} = 1{,}149\,997\,125\,81 = \alpha_1, \quad (93)$$

These coefficients indicate that transition from considering the velocity of the beam propagation in the medium to studying the dynamics of the photon step allows to penetrate more deeply into understanding the physical essence of light reflection.

The influence of chromatic aberration upon experimental results

A long-focus lens with focal distance of f = 6531 *mm* and $2f$ = 13062 *mm* according to the producer certificate was used in the experiment therefore chromatic aberration was firstly inevitable and secondly it was rather significant. In other words there was its own inherit focal distance for every monochromatic beam. But because it was very difficult to move the rotating mirror along the lens optical axis while changing over from one monochromatic beam to another one the rotating mirror was installed motionlessly at the point where the mercury lamp luminous plasma image (in diameter of d_1 = 5 *mm*) on the rotating mirror was equal to d_2 = 5 *mm* (at the distance of $2f$ from the lens) for the white light beam.

If the lens and the rotating mirror are positioned in such a way, the violet beams are focused before the mirror at the distance of l_1= 106 *mm*, and the red ones are focused behind the mirror at the distance of l_2= 201*mm* as are sult the path length was constant and equal for every beam under investigation but with a slight error of $\Delta L = \pm½(l_1 + l_2) =$ 153,5 *mm* and that makes up only 0.172% of the path length $L = 89.1$ *m* and so it does not introduce serious error into the final result, especially if one takes into account that anticipated differences in the velocities of the beams under investigation make up 17% to 85%.

Analysis of the experimental data

Technical characteristic of the optical system

The experiment was carried out at the underground part of the aerodynamic tunnel at Lomonosov Moscow State University Mechanics Institute where daylight could not penetrate.

It was technically difficult to take the reference line to every photographic exposure. In the upshot we managed it for the white light beam as it is shown on photo 1, where the reference line almost coincide with the right edge of the exposure and with the seventh vertical line of the coordinate scale (counting from left to right). The attempt to define the reference line for the red monochromatic beam was unsuccessful (photo 4), but the flare which appeared on the photo did not interrupt the integrity of the track.

The essence of the reference line is in the fact that it fixes the spatial point where the front of the beam under investigation enters the photo-camera and this point is the same for every ray bundles under investigation while the mirror does not rotate because all the crucial components of the optical system remain motionless while taking a set of pictures, only filters are changed and the camera is loaded.

$L = 89.1$ *m* is the path length,

$n_0 = 213.85$ *revolutions per second* is rotation frequency of the mirror, *const*,

$\omega_0 = 2\pi \cdot n_0 = 1343.659178$ *rad/s* = 76986 *degree per sec* is angular velocity of the mirror,

$R = 7.20$ *m* is the distance between the rotating mirror and the shield,

$\upsilon = 2\pi \cdot R \cdot n_0 = 9674.3460812$ *m/s* is sliding velocity of the beam along the photographic film and it is the same for every beam,

$\gamma = a_1/a = 40 \text{ mm}/5 \text{ mm} = 8$ is the magnification factor of the pictures,

$\varphi_i = \tau_i \cdot \omega_0$ is rotation angle of the mirror for latency period τ_i,

$\tau_i = L/c_i$ is latency period of the beam front,

$\Delta l_i = \tau_i \cdot \upsilon$ is deflection of the beam from the reference point on the photographic film while the mirror is rotating,

$\Delta l_i = \varphi_i \cdot R$ is the deflection of the beam from the reference point according to the angle of rotation,

$l_0 = 252$ *mm* is the total track length on the pictures, the same for every picture,

$l_0 = l_i + \Delta l_i f$ where l_i is the track length measured on the pictures from its right limit point till leaving the frame at the left edge of the picture,

$\Delta l_{if} = \Delta l_i \cdot \pi \cdot \gamma$, *mm* where π is the scanning angle of the beam defined by the rotating mirror,

γ is the magnification factor on the picture.

The measurement error is not exceeding ± 2 *mm*.

White light, photo 1

$c_1 = \overline{c_1} = 2.960692476 \cdot 10^8 m/s$ is the average velocity on the path (see (33)),

$\tau_1 = 3.009431095 \cdot 10^{-7} s$ is the retardation time of the beam front (see (34)),

$$\varphi_1 = \tau_1 \cdot \omega_0 = 4.04364971135 \cdot 10^{-4} rad \qquad (94)$$

is rotation angle of the mirror,

$$\Delta l_1 = \varphi_1 \cdot R = 2.91142779217 \cdot 10^{-3} m = 2.911 mm \qquad (95)$$

is deflection of the beams on the photographic film,

$$\Delta l'_{1f} = \Delta l_1 \cdot \pi \cdot \gamma = 73.172 \text{ mm} \qquad (96)$$

is the theoretical value of deflection of the beams on the picture,

$$\Delta l_{1f} = 60 mm \qquad (97)$$

is the value measured on the film

$$l'_1 = l_0 - \Delta l'_{1f} = 178.827 \text{ mm} \qquad (98)$$

is the theoretical value of the track length of the white light,

$l_1 = 192$ *mm* is the value of the track length measured on the picture,

$$\left.\begin{aligned} \Delta &= l_1 - l'_1 = 13.172 mm \\ \Delta &= \Delta l'_{1f} - \Delta l_{1f} = 13.172 mm \end{aligned}\right\} \qquad (99)$$

is divergence between experimental and theoretical values of the track length.

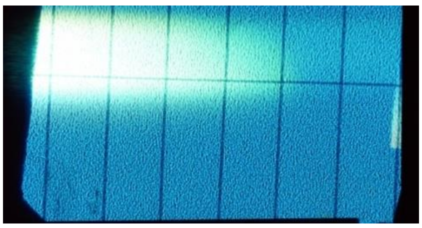

Photo 1. White light

It is rather difficult to explain this phenomenon from the current physics point of view, but the answer is quite simple if we take into consideration new theoretical ideas and new physical values introduced above. Most likely the initial point of the track is not shaped by the violet beams with the wavelength of $\lambda_{01} = 4 \cdot 10^{-7} m$, but by the ultraviolet beams which pass the path faster than the violet beams. The ultraviolet part of the high pressure mercury lamp spectre in the near-ultraviolet region is of intensity high enough to overexpose the film. It was registered by the convergence lens made of quartz glass with beam transmission up to $\lambda = 200$ *nm*.

The following calculations check and prove this presumption:

$$\Delta l_u = \frac{\Delta l_{1f}}{\pi \cdot \gamma} = \frac{60\text{mm}}{25.132741229} = 2.387324146mm \quad (100)$$

is deviation of supposed ultraviolet beam on the photographic film,

$$\tau_u = \Delta l_u / v = \frac{23.87324146 \cdot 10^{-4} m}{9.6743460812 \cdot \frac{10^3 m}{s}} = 2.46768528469 \cdot 10^{-7} s \quad (101)$$

is retardation time of the supposed ultraviolet beams front,

$$\bar{\lambda}_u = \mu / \bar{c}_u = \frac{89.1m}{2.46768528469 \cdot 10^{-7}} \times 3.61067112377 \cdot 10^8 m/s \quad (102)$$

is average velocity of the supposed ultraviolet beams on the path *L*,

$$\bar{\lambda}_u = \mu / \bar{c}_u = \frac{\frac{119.916984 m^2}{s}}{\bar{c}_u} = 3.32118268015 \cdot 10^{-7} m \quad (103)$$

is the average photon step of these beams representing really the near-ultraviolent region!

$$n_c = \bar{c}_u \Big/ \bar{c}_1 = \frac{3.61067112377 \cdot \frac{10^8 m}{s}}{2.960692476 \cdot \frac{10^8 m}{s}} = 1.219536$$

is the exceedance of the propagation velocity of ultraviolet beams over the propagation velocity of the violet beams on the path *L*,

$$n(c_0) = \frac{\bar{c}_u}{c_0} = 1.20439023842$$

is the exceedance of the propagation velocity of the ultraviolet beams in the air over the light velocity in vacuum, c_o!

$$k_{nu} = \frac{(n_u - 1)}{l_{unit}} = 2.876 \cdot 10^{-4} m^{-1} \quad (104)$$

is the spatial factor, where $n_u = 1.0002876$ for $\lambda_u = 3.321 \cdot 10^{-7} m$ [4, p. 791],

$n_u(L) = n_u + k_{nu} \cdot L = 1.02591276\ m^{-1}$

is the air refractive index on the path *L* for ultraviolet beams,

$$\lambda_{0u} = \frac{2\bar{\lambda}_u}{(2 + k_{nu} \cdot L)} = \frac{6.6423653603 \cdot 10^{-7} m}{2.02562516} = 3.279168077 \cdot 10^{-7} m \quad (105)$$

is the step of the photon of ultraviolet beams shaping the beginning of the mercury lamp white light bundle.

The received data depend insignificantly upon the lens reflection and absorption coefficients and the mirrors reflection factors in this experiment as well that is why they were not taken into consideration.

The results (101) to (106) show that near-ultraviolet beam propagates with the velocity higher even in the air than the light velocity in vacuum $c_0$by 20.4%. This result confirms clearly our discovery of *electrino* which acts as a light photon. It is wonderful that *electrino* even disproves Einstein relativity theory and prejudices continuation of conventional work at accelerators including Large Hadron Collider at *Centre Europeen pour la Recherche Nucleare* (CERN)!

Blue light, **photo 2**

$c_2 = \bar{c}_2 = 2.57403822353 \cdot 10^8 m/s$ (see (54)),

$\tau_2 = 3.46148708955 \cdot 10^{-7} s$ (see (55)),

$$\varphi_2 = \tau_2 \cdot \omega_0 = 4.65165885628 \cdot 10^{-4} rad \quad (106)$$

is rotation angle of the mirror,

$$\Delta l_2 = \varphi_2 \cdot R = 3.34876237652 \cdot 10^{-3} m = 3.348mm \quad (107)$$

is deflection of the beams on the photographic film,

$$\Delta l'_{2f} = \pi \cdot \gamma \cdot \Delta l_2 = 84.163\ mm \quad (108)$$

is the theoretical value of deflection of the beams from the defined point on the picture,

$$l'_2 = l_0 - \Delta l'_{2f} = 167.836\ mm \quad (109)$$

the theoretical track length,

$$\Delta l_{2f} = 86\ mm \quad (110)$$

is the experimental value of the front deviation

Photo 2. Blue light

$$l_2 = 166\ mm \quad (111)$$

is the value of the track length measured on the picture. It is turned out that the exposure of surveying the blue beams was not enough though it lasted 120 *min*.

The discrepancy between theory and experiment in this case does not go beyond the experimental error.

Green light, photo 3

$c_3 = \overline{c}_3 = 2.16855205357 \cdot 10^8 m/s$ (см. (68)),

$\tau_3 = 4.10873236145 \cdot 10^{-7} s$ (см. (70)),

$$\varphi_3 = \tau_3 \cdot \omega_0 = 5.5207355474 \cdot 10^{-4} rad \quad (112)$$

is rotation angle of the mirror for the time τ_3,

$$\Delta l_3 = \varphi_3 \cdot R = 3.97492988212 \cdot 10^{-3} m = 3.975 mm \quad (113)$$

is deflection of the beam front on the photographic film,

$$\Delta l'_{3f} = \pi \cdot \gamma \cdot \Delta l_3 = 99.90088\ m \quad (114)$$

is the theoretical value of front deflection on the picture,

$$l'_3 = l_0 - \Delta l'_{3f} = 152.1\ mm \quad (115)$$

is the theoretical value of the track length,

$$\left.\begin{array}{l} l_3 = 154mm \\ \Delta l_{3f} = 98mm \end{array}\right\} \text{are experimental values} \quad (116)$$

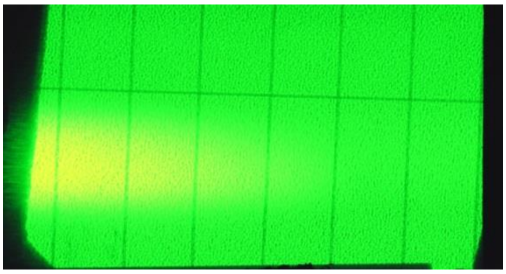

Photo 3. Green light

The experimental values for the green beams do not differ from the values predicted by the new theory.

Red light, **photo 4**

$c_4 = \overline{c}_4 = 1.55831813456 \cdot 10^8 m/s$ (83),

$\tau_4 = 5.71770282485 \cdot 10^{-7} s$ (84),

$$\varphi_4 = \tau_4 \cdot \omega_0 = 7.68264387768 \cdot 10^{-4} rad \quad (117)$$

$$\Delta l_4 = \varphi_4 \cdot R = 5.531150359192 \cdot 10^{-3} m = 5.531mm \quad (118)$$

is deflection of the red beams on the photographic film,

$$\Delta l'_{4f} = \pi \cdot \gamma \cdot \Delta l_4 = 139.002\ mm \quad (119)$$

is the theoretical value of deflection of the beams on the picture,

$$l'_4 = l_0 - \Delta l'_{4f} = 112.978mm \quad (120)$$

is the track length measured on the film

$$\left.\begin{array}{l} \Delta l_{4f} = 137\ mm \\ l_4 = 115mm \end{array}\right\} \text{are experimental values} \quad (121)$$

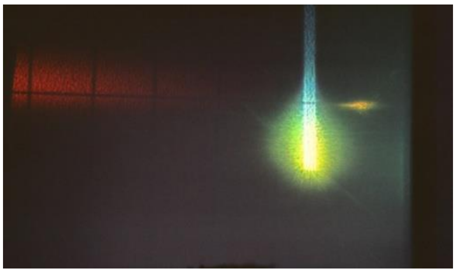

Photo 4. Red light

As one can see the divergence between experimental and theoretical values for the red beams is within the experimental error.

Taking into account the ratios of the track lengths to deflection lengths for the bundles under investigation, we can come to the following:

$$\delta_1 = \frac{l_u}{\Delta l_{uf}} = \frac{192mm}{60mm} = 3.2, \quad (122)$$

$$\delta_2 = \frac{l_1}{\Delta l_{1f}} = \frac{178.828mm}{73.172mm} = 2.44 \quad (123)$$

$$\delta_3 = \frac{l_2}{\Delta l_{2f}} = \frac{166.0mm}{86.mm} = 1.93 \quad (124)$$

$$\delta_4 = \frac{l_3}{\Delta l_{3f}} = \frac{154mm}{98mm} = 1.57 \quad (125)$$

$$\delta_5 = \frac{l_4}{\Delta l_{4f}} = \frac{137mm}{115mm} = 1.19 \quad (126)$$

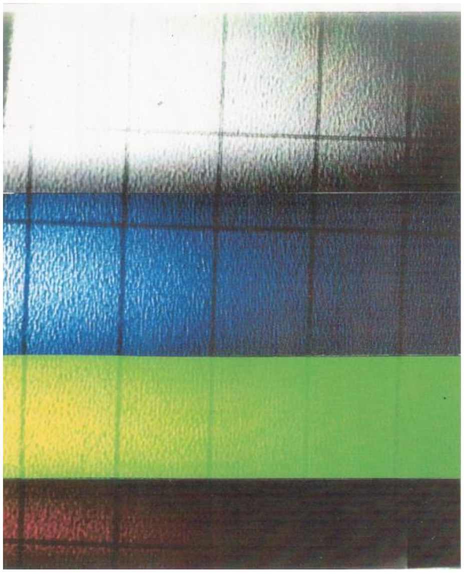

Photo 5. Arrangement of photos shown above of four monochromatic beams

Coefficients δ_1 to δ_5 are consequence of the results received experimentally and registered on the coloured photographic film. They can be easily reproduced at any optical laboratory. The results show that every monochromatic ray bundle of the natural light possesses its own velocity dependant on the photon step (or wavelength according to the old terminology) both in vacuum and in the air medium.

Final Conclusions

1. The propagation velocity of the light in the vacuum $c_0 = 2.9979246 \cdot 10^8 m/s$ is not a fundamental constant, the same for all kinds of radiation as it has been perceived before.
2. The velocity c_0 is the propagation velocity of only violet beams in the vacuum with photon step of $\lambda = 400$ *nm* according to the derived formula has the following refined value of $c_0 = \mu/4 \cdot 10^{-7} m/s = const.$
3. Light is no electro-magnetic wave, but it represents an electro-dynamic system shaped by axial negative field of the beam and the continuum of *electrinos* possessing limit mass and limit positive charge, independent of the movement velocity in the space.
4. The term *photon* introduced into the scientific terminology by G. Lewis in 1929 is of equivalent to the corpuscle mentioned by Newton in 1687. In essence they are presented here by a real, truly elementary particle *electrino,* which we discovered in 1982.
5. Theoretical results based on the discovery of the *electrino* were confirmed with experimental data in studies of light spectre and its velocities.

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