From the Editorial Board

This issue of the journal RENSIT, 2018, 10 (2) is devoted to the Anniversary of the Kotelnikov Institute of Radioengineering and Electronics of the Russian Academy of Sciences is his 65th birthday. In this connection, the Editorial Board considered it appropriate to publish materials of the 60-80s of the 20th century, software for such areas of research as radar, dynamic chaos, biomedical radio electronics and information technology. Modern research, continuing this topic, are presented in issue by the work of the current staff of the Institute.

KOTELNIKOV INSTITUTE OF RADIOENGINEERING AND ELECTRONICS OF RUSSIAN ACADEMY OF SCIENCES - 65 YEARS OLD

Yuri V. Gulyaev

Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences, http://www.cplire.ru/
Moscow 125009, Russian Federation
gulyaev@cplire.ru

Abstract. **Information is presented on the establishment of the institute, on the initiators of its education, on the leaders of the first scientific divisions, on the composition of the leading staff - doctors and candidates of science, on the branches of the Institute in the Moscow region and Russia. 17 scientific directions in the field of radio engineering, radiophysics, electronics and informatics, realizing the main task of the Institute, are listed. The main achievements of the IRE are also listed. IRE RAS for the 65-year period of activity and the most significant scientific results of the Institute received in recent years, also listed. The evaluation of the activity of the IRE from the side of the Government of our country, its Academy of Sciences and foreign scientific organizations, expressed in the awards of both the Institute as a whole and a large number of its employees - orders and medals, higher state ranks, numerous awards, incl. international.**

Keywords: **institute, initiators of creation, heads of divisions, achievements, awards**

PACS 01.10 Fv

Bibliography - 5 references *Received 03.09.2018*

RENSIT, 2018, 10(2):133-146 **DOI: 10.17725/rensit.2018.10.133**

Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences (Kotelnikov IRE RAS) was formed by the decision of the Council of Ministers of the USSR of August 29, 1953 and the corresponding resolution of the Presidium of the USSR Academy of Sciences on September 18, 1953 to investigate the generation, propagation and channeling of electromagnetic energy for the analysis of physical processes and the development of the theory of phenomena in semiconductor materials and electronic devices, the development of new methods for measuring magnetic and electric quantities, and also to search for new applications of radio engineering methods in science, economy and defense techniques [1]. For its placement in the same year, the building of the physical institute and the physical faculty of the Lomonosov Moscow State University on Mokhovaya Street, house 11 (**Fig. 1**) was allocated, where the Institute is located at the present time (**Fig. 2**).

Fig. 1. *Physics Faculty of Lomonosov Moscow State University, photo 30-ies of the 20th century.*

Fig. 2. *Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences.*

The initiators of the Institute's formation and the leaders of the first scientific divisions were the prominent scientists: academicians A.I. Berg (director-organizer), B.A. Vvedensky, N.D. Devyatkov, Yu.B. Kobzarev, V.A. Kotelnikov (director of the IRE from 1954 to 1987), V.V. Migulin, Corresponding Members of the USSR Academy of Sciences D.V. Zernov, V.I. Siforov, A.A. Pistolkors.

The heads of the first scientific divisions were also Doctors of Sciences A.G. Arenberg, N.A. Armand, A.E. Basharinov V.I. Bunimovich, G.S. Gorelik, M.I. Elinson, M.E. Zhabotinsky, L.A. Zhekulin, SG Kalashnikov, B.Z. Katsenelenbaum, M.A. Kolosov, T.M. Lifshitz, R.V. Matveev, Ya.E. Monosov, V.B. Sandomirsky, A.V. Sokolov, Z.S. Chernov, B.M. Tsarev, N.L. Yasnopolsky.

Hereinafter, academicians Yu.V. Gulyaev (director from 1987 to 2014), A.S. Bugaev, N.A. Kuznetsov, V.I. Pustovoit, V.Ya. Shevchenko; corresponding members of the RAS V.G. Mokerov, S.A. Nikitov, Ya.E. Pokrovsky, D.I. Trubetskov, V.A. Cherepenin, as well as numerous detachment of doctors and candidates of sciences of the Institute made a great contribution to the its formation and development.

In order to develop large-scale research, strengthen the material and technical base of the Institute and accelerate the introduction of research results into industry, in Fryazino, Moscow Region, in 1955, according to the resolution of the USSR Council of Ministers, the Fryazino part of the IRE was formed (now the Fryazino branch of IRE RAS, director of the branch Dr. Sc. V.M. Smirnov), and in 1958, by the decree of the Presidium of the USSR Academy of Sciences, the Special Design Bureau (SDB) of the IRE was created (now the director is chief designer of the SDB IRE RAS V.V. Abramov). Later in 1979, on the initiative of Academician Yu.V. Gulyaev created the Saratov branch of IRE RAS, headed by Ph.D. G.T. Kazakov (now the director of the branch is Dr.Sci. Yu.A. Filimonov), and in 1990 - the Ulyanovsk branch of IRE RAS, headed by Ph.D. A.A. Shirokov (now the director of the branch is Dr.Sci. Techn. V.A. Sergeev).

Currently, the IRE RAS, including 3 branches, employs more than 1000 employees, including 3 academicians, 4 corresponding members of the RAS, about 130 doctors and more than 280 candidates of science. Director of the Institute is a laureate of the Government of the Russian Federation Prize, Corresponding Member of the RAS Sergei Apollonovich Nikitov.

The main task of the Institute is to conduct fundamental and applied research in the field of radio engineering, radiophysics, electronics and computer science in the following 17 scientific areas:

- radiophysical studies of planets and outer space;
- remote sensing of terrestrial cover and atmosphere;
- propagation of radio waves and electrodynamics of various media and structures;
- statistical radiophysics;
- generation of electromagnetic oscillations;
- nonlinear dynamics and dynamic chaos;
- biomedical radio electronics and informatics;
- optoelectronics and fiber optics;
- physical acoustics and acoustoelectronics;
- physics of magnetic phenomena and magnetoelectronics;
- condensed matter physics;
- physics of semiconductors and semiconductor electronics;
- molecular electronics;
- technology of new materials and structures for radio engineering and electronics;
- physics of low-dimensional structures, micro- and nanoelectronics;
- superconducting electronics;
- informatics, telecommunications, radar.

The Institute prepares scientific personnel of the highest qualification through postgraduate and doctoral studies, three doctoral dissertational councils work at the Institute.

To the most important achievements of Kotelnikov IRE RAS for the 65-year period of activity can be attributed the following.

- Radiolocation of the planets Venus, Mars, Mercury and Jupiter in the period 1961-1982.

- Mapping the surface of Venus with spacecraft Venera-15 and Venera-16
- Asteroid radiolocation
- Investigation of natural resources by radiometric methods
- Sonar the bottom of the seas and oceans
- Studies of atmospheres, ionospheres of planets and near-solar plasma by radiophysical methods
- Propagation of millimeter and submillimeter waves in the Earth's atmosphere
- Development of supersensitive quantum paramagnetic amplifiers for planetary radar and radio astronomy studies
- Investigations in the field of generation of powerful electromagnetic oscillations by electron beams
- Studies on the nonthermal effect of powerful electromagnetic pulses on rocks
- Development of scientific foundations and devices of biomedical radioelectronics
- Development of scientific foundations and devices of EHF-therapy
- Development of broadband telecommunications and information technologies based on dynamic chaos
- Pioneering work in the field of acoustoelectronics, including theoretical prediction and experimental detection of a new fundamental type of surface acoustic waves (Gulyaev-Bluestein waves)
- Fundamental work in the field of acousto-optics, magnetoelectronics (including spinwave electronics and spintronics), superconductor electronics
- Pioneering work on the study of carbon nanotubes, graphenes and other low-dimensional electronic systems
- Pioneer work in the field of semiconductor physics.

The following outstanding scientific results of the Institute, received in recent years and noted in the annual reports of the Russian Academy of Sciences, can be noted.

- A superconducting integrated spectrometer in range 450-650 GHz for monitoring atmosphere on the basis of tunnel nanostructures Nb-AlN-NbN was created and tested. Successful launch of the on-board integrated spectrometer was held at the "Esrange" polygon (Sweden) (noise temperature of 120 K, spectral resolution is better than 1 MHz). During the flight on a high-altitude balloon, the spectra of various gas components, including ClO and BrO were measured, responsible for the destruction of the ozone layer of the Earth, their distribution in the altitude range 12-36 km during the sunrise (IRE RAS, Institute of Physics of Microstructures of RAS, National Institute Space Research of the Netherlands).
- Based on the Ni-Ti-Cu alloy with shape memory effect (ESM) coated with a platinum layer, samples of composite microinstruments, in particular nanopincetes and nanoscraps, with overall dimensions of 1-15 microns were made. A prototype of system for manipulating nanoobjects was created on the basis of a nano-tweezer with an ESM, that docked with an Omniprobe nanomanipulator and with a semiconductor injection laser controlled by a beam. Three-dimensional manipulation of stacks of graphene sheets, carbon nanotubes bundles and microfibers of biological nature is demonstrated. The size of the captured and manipulated object is 10-1000 nm (IRE RAS, Moscow Engineering Physics Institute, Moscow Institute of Steel and Alloys, FTI RAS).
- The state induced by a strong magnetic field with a charge density wave in graphite is revealed. This state is explained by the charge density wave arising in graphite due to the one-dimensionalization of its electronic spectrum under the action of a magnetic field. The possibility of its existence was predicted theoretically by Yoshioka and Fukuyama more than 30 years ago to explain the anomaly of the magnetoresistance of graphite in strong fields at low temperatures (Institute for Physics and Technology of RAS, Institute of Neel, Grenoble, France and the National Laboratory of Pulsed Magnetic Fields, Toulouse, France).
- The principles of building wireless ultra-wideband communication networks and sensor

networks with energy-saving functions are developed. Specifically designed, manufactured and tested experimentally low-consuming ultra-wideband direct-chaotic transceivers with various energy-saving modes; network management algorithms have been created that allow the self-organization and self-diagnosis functions of the network to be realized, taking into account the power-saving modes of the transceivers; created algorithms for data transmission over the network, taking into account energy-saving modes; implemented and experimentally explored the mock-up of a wireless voice transmission system based on a self-organizing network. (IRE RAS).

- A new method for evaluating the wavelet spectrograms of the brain's electroencephalogram (EEG) is developed, focused on the search for signs of Parkinson's disease (PD) at an early stage. The essence of the method is the analysis of the statistics of the frequency-time distribution of local extrema of the EEG wavelet spectrograms, since the interhemispheric asymmetry of the frequency-temporal distribution of the local maxima of the wavelet spectrograms is noted when comparing the wavelet spectrograms of the EEG symmetric cortical regions in patients with the first stage of the PD (IRE RAS, IHNA&NPh RAS, Scientific Center of Neurology of RAMS).
- For the first time, chains of bolometers on cold electrons have been created that are record-sensitive to terahertz radiation and insensitive to cosmic rays. For the first time in Russia, optical sensitivity values at the level of 20 $aW/Hz^{1/2}$ were obtained under background radiation conditions at the level of 3 K (IRE RAS, Kapitza IPP RAS, Chalmers University, University of Rome).

In the State Register of Discoveries of the USSR 8 discoveries made by the Institute's employees were registered.

For 65 years of its existence, the Institute's works have been awarded two prizes of the European Physical Society, two Lenin Prizes, 24 State Prizes of the USSR, six State Prizes of the Russian Federation, four Prizes of the Council of Ministers of the USSR, three Prizes of the Government The Russian Federation, 3 Lenin Komsomol Prizes, 2 State Prizes of the Ukrainian SSR, 1 Prize of the Government of the Russian Federation in Education and 1 State Prize of the Russian Federation named after Marshal of the Soviet Union G.K. Zhukov in the field of military science.

For success in scientific activities, the IRE was repeatedly praised by the Council of Ministers of the USSR and the Government of Russia, as well as by the Academy of Sciences of the USSR, the Russian Academy of Sciences and foreign scientific organizations.

In 1969, the IRE Academy of Sciences of the USSR was awarded the Order of the Red Banner of Labor. A number of the Institute's employees were awarded the title Heroes of Socialist Labor (academicians ND Devyatkov, Yu.B. Kobzarev, VA Kotelnikov (twice)). Many employees of the Institute were awarded orders and medals for fruitful scientific and public activities. Academician V.A. Kotelnikov was awarded the Order of Merit for the Fatherland, I degree, and Academician Yu.V. Gulyaev - orders Order of Merit for the Fatherland, IV and III degrees.

A number of the Institute's employees for scientific achievements were awarded prestigious international prizes awarded by the International Institute of Electrical and Electronics Engineers (IEEE): Academician V.A. Kotelnikov - Gold Medal of A.G. Bell (and also the prize of the Eduard Raine Foundation (Germany)), academician Yu.V. Gulyaev - Rayleigh Award, Dr.Sc., Prof. G.D. Mansfeld - Cady's award, Dr.Sc. M.A. Tarasov - the award to them Van Duser.

A number of employees of the Institute were awarded prestigious prizes and awards from the Academy of Sciences of the USSR and the Russian Academy of Sciences: A.S.Popov Prize (M.I. Elinson, A.G. Zhdan, A.N. Vystavkin, T.M. Lifshits, M.E. Zhabotinsky), the B.P. Konstantinov Prize (Yu.V. Gulyaev), a gold medal named after

A.S. Popov (V.A. Kotelnikov, Yu.B. Kobzarev, N.D. Devyatkov, Yu.V. Gulyaev), a gold medal named after M.V. Lomonosov (V.A. Kotelnikov), a gold medal named after M.V. Keldysh (V.A. Kotelnikov).

14 employees of the Institute were awarded the honorary title of "Honored Worker of Science and Technology".

APPENDIX

Directors of V.A. Kotelnikov IRE RAS

The first director of the IRE was **AKSEL IVANOVICH BERG**, an engineer-admiral, doctor of technical sciences, an academician of the USSR Academy of Sciences in the Division of Technical Sciences (**Fig. 3**), deputy minister of defense of the USSR in those years, served as managing director of the IRE in 1953-1955 [2].

Axel Ivanovich was born on November 10, 1893 in Orenburg, in the family of Russian general Johann Alexandrovich Berg, a Swede by birth, and Italian Elizabeth Camillovna Bertholdi, whose ancestors moved to Russia. At the birth of son, he was given, according to the Lutheran custom, the double name Axel-Martin.

After four years of study in St. Petersburg's Petrishule, Axel studies in the Alexander Cadet Corps, after which he studies since 1908 in the Naval Cadet Corps, which graduated in 1914 in the rank of midshipman. In the same year he married Nora Rudolfovna Betlingk, the daughter of a famous Petersburg therapist. Serves two years in Finland, in Helsingfors (Helsinki) on the battleship "Tsesarevich", where he goes as a company commander, after which - almost a year navigator of a submarine that took part in the fighting of the First World War. After studying in the winter lull of military operations, in February 1917 he received the rank of lieutenant.

Fig. 3. *Aksel Ivanovich Berg - the director-organizer of the Institute of Radioengineering and Electronics of the USSR Academy of Sciences.*

During the October Revolution, Berg was at sea and heard about it only after the submarine returned to the base. Soon there was a separation of Finland from Russia, Berg and his wife managed to take the last train to Petrograd. Here, after a brief service onyo the destroyer, Berg gets to the fleet command headquarters, takes out submarines from Finland, heads by the restoration of damaged submarines.

At the same time he studies at the Petrograd Polytechnic Institute. After demobilization from the active fleet on health, he studies at the Higher Naval Engineering College (electrical and radio engineering), then at the Naval Academy, teaches radio engineering (the first textbooks, including the "General Theory of Radio Engineering"), after its completion in 1925 he teaches at the College. In 1928, he divorced Nora (a childless marriage) and married Marianna Ivanovna Penzina.

In 1928-32 he was sent to purchase hydroacoustic instruments into Germany, the United States, Italy. He organizes a scientific and testing ground (1927), then - the Maritime Institute of Communications (1932), develops and implements a system for the radio equipment of the fleet. In 1936, the attestation commission awards A.I. Berg the scientific degree of Doctor of Technical Sciences In 1937 he was awarded the Order of the Red Star.

At the end of 1937 he was arrested on suspicion of participating in the "Tukhachevsky case". For 2.5 years in prisons of Kronstadt and Moscow he communicated, among other things, with Marshal Rokossovsky, constructor Tupolev, academician Lukirsky and others. In 1940 was released "for insufficiency of evidence". All ranks and academic degrees to Axel Ivanovich were returned, he appointed as the head of the chairs at the Naval

Academy. With which in 1941 engineer-Rear Admiral Berg was sent to evacuation to Astrakhan, then to Samarkand.

In the first years of the war, a new direction in radio electronics was born - radiolocation. At the end of 1942 Axel Ivanovich sent to Moscow his project for the development of radar works in the USSR and, being summoned to the capital, walked around the offices of officials with his posters along radar. This ended in 1943 with the resolution of the State Committee for Defense "On Radiolocation" and the creation of a Council for radar with the inclusion of all color of radar thoughts of Russia of those years. Berg himself by the seventh point of the decision was approved by the Deputy People's Commissar of the electricindustry along radiolocation, and then by deputy Chairman of the Council on radar in the GKO USSR.

In August 1943 Berg was also entrusted, among other things, with the duties of the head of the "radar institute" designated in the decree "On radiolocation." In September, the institute was given the name "VNII №108" (today - CNIRTI named after Academician A.I. Berg). Thanks to Axel Ivanovich, who was actively engaged in the selection of specialists, by the end of 1944 eleven laboratories were created at VNII-108. As a director of the Institute, Berg worked until 1957. Under his leadership in the "one hundred and eighth" were started work in the field of radioelectronic warfare.

In 1953, Berg was appointed Deputy Minister of Defense of the USSR for radio armament. This was the highest point in his career - being the second person in the "power" ministry he could influence the solution of the most diverse issues of the country's defense industry. Possessing the appropriate powers and knowing perfectly well that his "one hundred and eighth" institut is littered with works of a defensive nature and is unable to deal with the vital issues of radio electronics productively, Berg decided to organize the Institute of Radioengineering and Electronics at the Academy of Sciences of the USSR in the capital of the country. In September 1953 a corresponding decree of the Presidium of the Academy of Sciences was issued, and Axel Ivanovich was appointed as the director-organizer of the new institut.

Painstaking work began - selection of scientists, correspondence with the Ministry of Culture on the allocation of new premise to the new institute, the creation of the first bylaws. In August 1955, Berg was awarded the title of Engineer-Admiral. Unfortunately, the enormous burden on the posts of the Deputy Minister of Defense of the USSR, which Axel Ivanovich combined with participation in the Radio Council of the Academy of Sciences and the leadership of the Central Research Institute-108, undermined his iron health. A bilateral infarction in July 1956, three months in the hospital, a year and a half in sanatoria. In one of them, he met with a nurse Raissa Glazkova. She was younger than Axel Ivanovich on thirty-six years, but this difference because of the "motor" nature of Berg was not strongly felt. Soon the radio engineer decided to marry for the third time. Raissa Pavlovna, a large, sedate and skillful woman, was very different from the other he life partnerins - the morbid Nora Rudolfovna and the miniaturic Marianna Ivanovna, who agreed to divorce only after the birth of Margarita - daughter of Berg and Raissa Pavlovna in 1961. By "young father" Axel Ivanovich became at the age of sixty-eight.

In May 1957, in connection with the state of health and at his personal request, Berg was relieved of his post as Deputy Minister of Defense and concentrated his forces at work in scientific research institutions of the Academy of Sciences. In January 1959, the Presidium of the Academy of Sciences instructed him to form a commission for the preparation of a report titled "Basic Problems of Cybernetics." In April this year, following the discussion of the report, the Presidium of the Academy of Sciences adopted a resolution to establish the Scientific Council for Cybernetics. The main structural subdivision of the Council was its sections, to the work of which on a voluntary basis attracted more than eight hundred scientists (including eleven academicians). Such a Council already corresponded to the size of a large scientific research institute.

Gradually, through the efforts of Berg and a number of his associates, cybernetic ideas were

widely disseminated among Russian scientists. Symposiums, conferences and seminars on cybernetics, including at the international level, have been held every year. The publications "Cybernetics - in the service of communism" and "Problems of Cybernetics" were published, ten or twelve collections of "Problems of Cybernetics" were published annually. In the sixties institutes of cybernetics appeared in all the Union republics, in high schools - the laboratories and chairs, in the branch institutes - the laboratories. Also new fields of cybernetic science appeared: artificial intelligence, robotics, bionics, situational management, theory of large systems, interference-steadfast coding. The priorities in mathematics also changed, because in the presence of a computers, it became possible to process large amounts of information. In 1963, Berg was awarded the title of Hero of Socialist Labor.

Berg paid a great deal of attention to the propaganda of knowledge among the masses, mainly among radio amateurs. Axel Ivanovich possessed an outstanding oratorical talent. His speeches left an indelible impression on the listeners and were remembered for life. Non-standardness of narration, free manipulation with statistical data, the breadth of problems, witty aphorisms and replicas - all this captivated, amazed the listener. Axel Ivanovich was the initiator of the founding of the publishing house of the "Massing Radio-library", which produces works of radio amateur. The publishing house began to function in 1947, Axel Ivanovich headed his editorial board until his death.

Axel Ivanovich died at the age of eighty-five years on the night of July 9, 1979 in the hospital ward. Buried at the Novodevichy Cemetery.

The second director of IRE RAS, Academician **VLADIMIR ALEKSANDROVICH KOTELNIKOV**, held this post in 1954-1988.
V.A. Kotelnikov is an outstanding scientist, engineer, teacher and organizer, one of the founders of radiophysics, radio engineering, computer science, radio astronomy and domestic cryptography. His pioneering work laid the foundation for the development of new areas of science and technology: informatics and the digital method of signal transmission, statistical radiophysics, planetary radar, domestic cryptography and large-scale space exploration [3].

V.A. Kotelnikov was born 110 years ago, on August 24 (September 6), 1908 in Kazan. His grandfather and father were professors of Kazan University. By the age of six Volodya already read, wrote, mastered the initial courses of arithmetic, algebra, geometry. During the First World War, revolutions and the Civil War, the family moved from town to town, and Volodya continued his education independently according to the books available in their house. At school he studied only the last three classes, and finished it in 1925.

Remaining faithful to his childish and youthful enthusiasm for radio engineering, Vladimir wanted to enter the Electrotechnical Faculty of the N.E. Bauman MVTU, but there they accepted only "persons of worker-peasant origin" after the rabfak, and in his documents it was "from the nobility." It took a year to study in the technical school of communication, but in 1926 the MVTU announced a "free reception", and Vladimir easily entered there. Simultaneously with his studies at the Moscow Higher Technical University, he attended courses at the Physics and Mathematics Department of Moscow State University. In 1930 he graduated from the Moscow Power Engineering Institute (MEI), which was graduated from the Moscow Higher Technical School just in the year

Fig. 4. *Vladimir Alexandrovich Kotelnikov - director of the Institute of Radioengineering and Electronics of the USSR Academy of Sciences from 1954 to 1988.*

of graduation. After graduation he worked at the Research Institute of Communications of the Red Army. In 1931 he enrolled in the graduate school of MEI (1931-1933) and simultaneously worked as a laboratory assistant, then as assistant, assistant professor (1931-1938), head of the chair of Radio Engineering of the MEI (1938-1941). The Central Institute of Communications of the People's Commissariat of Posts and Telegraphs (CNII CNS) is the engineer, chief engineer of the institute on radio, head of the laboratory (1933-1941). State Union Industrial and Experimental Institute No. 56 - head of the laboratory, Ufa (1941-1943), Department of Government Communication of the People's Commissariat of Internal Affairs of the USSR Moscow (1943-1944). MEI - professor, head Department of Radio Engineering, Dean of Radio Engineering Faculty (1944-1980). IRE USSR Academy of Sciences - Deputy Director (1953-1954), Director (1954-1987), Honorary Director (1987-2005). Presidium of the USSR Academy of Sciences - acting vice president (1969), vice president (1970-1988).

The creative path of Vladimir Aleksandrovich Kotelnikov covered 78 years. He began in 19 years, the creation of the first in our country device "triple characterograph". This work was carried out after the first course of the MVTU during the summer holidays at the Nizhny Novgorod Radio Laboratory (1927). It was published in 1928.

At 24, he was the first to mathematically precisely formulate and prove, in the aspect of communication technology, which later became the classic "Sampling Theorem" ("Kotelnikov Theorem"), which marked the beginning of information theory, digital messaging systems, control, coding and information processing.(MEI, 1932).

At the age of 27, under his leadership and with his participation, the first multi-channel letter printing machine for radio work was set up in our country, which significantly exceeded foreign analogues in its parameters and was subsequently widely used in our country (1935).

At the age of 30 he was awarded the degree of Candidate of Technical Sciences without defending a thesis (1938, Leningrad Electrotechnical Institute), he became a head the Chair of Radio Engineering Basics MEI.

At the age of 31, a unique multi-channel telephone and telegraph equipment for radio communications was created, using for the first time one sideband of frequency, which was installed on the Moscow-Khabarovsk (1939) line. This highway was the largest achievement of domestic and world radio engineering of that time.

At the age of 32, for the first time, fundamental in the development of cryptography a theorem was formulated and proved, that clearly defined the criteria for a mathematically undecryptable system (1941, NIIS NCS). At the same time, a new class of domestic undecryptable systems of speech coding for closed radio communication was created (1941-1943, Ufa). These systems were successfully used in the active army, as well as during the acceptance of Germany's surrender to link the Soviet delegation to Moscow (1943-1945). Subsequently, improved systems of this type have been successfully used for government communications up to the 1970s.

At the age of 36, he recreated and headed the Chair of Theoretical Foundations of Radio Engineering at the Radio Engineering Department of the MEI, which he subsequently directed for 36 years (1944-1980). In 1944-47 under his leadership, telemetric equipment for aircraft was developed.

At the age of 38, the "Theory of potential interference-steadiness" (doctoral dissertation), one of the main branches of information theory, in which the foundations of a new scientific direction - statistical radiophysics were laid - was created. This work, far ahead of its time, later became one of the cornerstones of modern communication theory (1946, MEI).

In 39 years - created and headed the "Sector of special works for scientific research in the interests of reactive weapons" (subsequently OKB MEI) - one of the leading organizations that developed radio electronic equipment for rocket and space programs (1947, MEI). As the chief designer of the Special Sector in 1947-1953, he was a member of the interdepartmental Council of Chief Designers, headed by S.P. Korolev. Elected Dean of the Radio Engineering Faculty of the MEI (1947-1953).

At the age of 45 he was elected a full member of the Academy of Sciences of the USSR, bypassing the degree of corresponding member (1953), appointed deputy Director of the Institute of Radioengineering and Electronics (IRE) of the USSR Academy of Science.

At the age of 46, he became the director of the IRE of the Academy of Sciences of the USSR, which he created and which in a very short time became one of the leading scientific institutions in the field of radio electronics, both in our country and abroad. He headed the institute for 33 years (1954-1987), remaining then an honorary director and continuing to head the scientific council of the Institute for another 18 years, until the end of his life.

With the name of V.A. Kotelnikov connected a new direction in the exploration of outer space - planetary radar, a new page in radio astronomy was opened: on his initiative, under his leadership and direct participation, unique experiments were carried out for the radiolocation of Venus (1961-1964), Mercury (1962), Mars (1963) Jupiter (1963). As a result of these studies, the value of the astronomical unit was determined with high accuracy, a new theory of the motion of the inner planets of the solar system was created and experimentally confirmed. The astronomical unit, specified by him together with his colleagues, made it possible to provide the necessary accuracy of control over the movement of space vehicles. An outstanding worldwide achievement was the radar survey of Venus, carried out in 1983-84 with the help of the onboard complex radar system AMS "Venera-15 and -16", thanks to which it was possible to obtain an image of the northern part of the planet with an area of 115 million km^2 with a resolution of 1 km. As a result of the analysis of these unique data, the first in the history of science, "The Atlas of the Surface of Venus" (Moscow, MIIGAiK, 1989) was created and subsequently published; editor-in-chief is academician Kotelnikov (1961-1989, IRE).

At the age of 88 and 89 years he published his latest articles, closing the circle of his work in the field of radiophysics (1996, 1997).

The creative path of Vladimir Alexandrovich was completed on the 97th year of his life, by the almost finished but not published work "Model Quantum Mechanics" (published in 2008, after the departure of Vladimir Alexandrovich from life).

Vladimir Alexandrovich Kotelnikov was a talented teacher. In MEI he was the first to introduce the teaching of courses in theoretical physics and to establish a new specialty "Radiophysics". In 1949, he developed the "Program on the theoretical fundamentals of radio engineering" for the specialty "Radio Engineering", for which for many years the students of this specialty were trained in all universities of our country. He was a brilliant lecturer (1931-1941, 1944-1955). His course of lectures "Fundamentals of Radio Engineering" was published in the form of a two-volume textbook with the same title (in 1950 and 1954) and enjoyed immense popularity. Vladimir Alexandrovich organized and for a long time headed the Chair of Electromagnetic Waves at the Moscow Institute of Physics and Technology (1968-1999).

Along with the solution of scientific problems and pedagogical activity, Vladimir Aleksandrovich was engaged in great scientific and organizational activities. In the years 1969-1988. V.A. Kotelnikov was acting president, vice president, first vice-president of the USSR Academy of Sciences.

Vladimir Alexandrovich headed a number of scientific councils, including the Scientific Councils of the USSR Academy of Sciences on the complex problem "Radio Astronomy" (1961-1989) and "Radiophysical Methods of Studies of the Seas and Oceans" (1978-2005). In 1980-2005, he was the vice-chairman of the Scientific Council on Space and headed the Council for International Cooperation in the field of study and use of outer space "Intercosmos". He actively worked as chairman of the section of radio electronics in Comitee for the Lenin and State Prizes of the USSR in the field of science and technology under the Council of Ministers of the USSR.

Vladimir Alexandrovich was the founder and editor-in-chief of the journal "Radio Engineering and Electronics" (1956-80), the editor-in-chief of the "Bulletin of the Academy of Sciences of

the USSR" (1974-88), and also a member of the editorial board of the journal "Radiotekhnika".

Academician V.A. Kotelnikov enjoyed deserved authority not only in our country, but also abroad. He was a member of many scientific organizations, including: 16 Russian, international and foreign academies, vice-president of the International Academy of Astronautics (1983-95), a member of the International Institute of Electronics and Electrical Engineers IEEE (elected in 1964, since 1987 Honorary Member), a member of the International Scientific Radio Union (1957-2005). Vladimir Alexandrovich was elected to the Supreme Soviet of the RSFSR (1971-80), Chairman of the Supreme Soviet of the RSFSR (1973-80), deputy of the Supreme Soviet of the USSR (1979-89).

For his scientific merit V.A. Kotelnikov was awarded the 31st state award, among which - two Orders "For Services to the Fatherland" - 1st degree (No. 4) and 2 nd degree; two stars of the Hero of Socialist Labor, six Orders of Lenin; two State Prizes (Stalin Prizes 1st degree); The Lenin Prize, the Council of Ministers Prize. He was awarded with high scientific awards - a gold medal named after A.S. Popova (1974), a gold medal named after M.V. Lomonosov and the Gold Medal with the MV Keldysh Prize for a series of works on the study of outer space. The international scientific community noted his scientific achievements with 17 international and foreign medals and prizes. International Institute IEEE awarded Vladimir Alexandrovich in 1973 with the medal. Hernand and Sozenes Ben for his outstanding contribution to the development of the theory and practice of radio communications, in 1999 the highest annual award - Alexander Graham Bell for his fundamental contribution to the theory of signals, in 2000 the highest medal of honor - the Gold Medal in honor of the III-th millennium for outstanding achievements in the fields of his scientific activity. In 1998 the International Academy of Astronautics awarded V.A. Kotelnikov with his highest annual award - the Von Karman Award.

The International Science Foundation of Eduard Rein (Germany) in 1999 awarded V.A. Kotelnikov by his main prize behind the sampling theorem, the first time mathematically precisely is formulated and proved in the aspect of communication technologies. Thus the priority of V.A. Kotelnikov is internationally recognized, although in the English-language literature this theorem is known as the Nyquist-Shannon theorem.

V.A Kotelnikov is an honorary professor at the Moscow Power Engineering Institute and St. Petersburg Electrotechnical University. For the adjuncts of the Institute of Cryptography, Communications and Informatics of the Academy of the Federal Security Service, were established two scholarships named V.A. Kotelnikov.

By the name of V.A Kotelnikov is named the Small Planet No. 2726 (in the International Catalog Circular No. 9214). His name carry a naval vessel, the Institute of Radioengineering and Electronics of the Russian Academy of Sciences (Decree of the Presidium of the RAS No. 274 of December 18, 2007) and also an institute within the MEI University.

February 1, 2005 V.A. Kotelnikov died, was buried at Kuntsevo Cemetery in Moscow

The third director of IRE RAS - academician **YURI VASILIEVICH GULYAEV,** held this post in 1988-2014.

Academician of the Russian Academy of Sciences Yuri Vasilievich Gulyaev is an outstanding Russian scientist in the field of solid state physics,

Fig. 5. *Yury Vasilievich Gulyaev - Director of IRE RAS from 1988 to 2014.*

radiophysics, electronics and computer science, one of the founders of new scientific and technical directions - acoustoelectronics, acousto-optics, spin-wave electronics, and biomedical radioelectronics [4].

Yuri Vasilievich Gulyaev was born in the village Tomilino, Lyubertsky district, Moscow region. Father Gulyaev Vasily Sergeevich, an economist, fought from the first day of the war and until the very end, was contused, had many military awards. Mother Anisimova Eugenia Dmitrievna, worked as a doctor all her life, went through the whole war.

In 1952 Yuri Gulyaev graduated Luberetskaya secondary school with a silver medal and entered the Moscow Institute of Physics and Technology, which graduated in 1958 with Honours. In 1962 he defended his candidate thesis, in 1970 - doctoral.

Since 1960 Yu.V. Gulyaev works in the Kotelnikov Institute of Radioengineering and Electronics of Russian Academy of Sciences (V.A. Kotelnikov Institute of RAS) as a junior researcher, senior research fellow, head of the laboratory, deputy director (from 1972 to 1988), director (from 1988 to 2014). At present, he is the scientific director of the Institute, the chairman of its Academic Council.

Since 1972 Yu.V. Gulyaev heads a chair at the Moscow Institute of Physics and Technology, the modern name of which is the Chair of Solid State Electronics, Radiophysics and Advanced Information Technologies.

For the years of his creative work Yu.V. Gulyaev prepared over 80 candidates of science, 20 of whom became doctors of science, with one of his pupils elected a corresponding member of the Russian Academy of Sciences, the other an academician of the Russian Academy of Sciences. Yu.V. Gulyaev is a laureate of the Russian Federation Government prize in the field of education (2009). Total Yu.V. Gulyaev single-handed, as well as together with his students and employees, published more than 700 scientific articles in the most prestigious domestic and foreign scientific journals, received more than 80 patents for inventions. He is the co-author of 11 monographs. He is also a co-author of the discovery - the so-called acoustomagnetoelectric effect (diploma No. 133).

Yu.V. Gulyaev is one of the creators of a number of the most promising directions in modern radio electronics, such as acoustoelectronics and acoustooptics, spin-wave electronics and spintronics, and biomedical radioelectronics. His name and works are world famous. In 1968 simultaneously with the American scientist Jeffrey L. Bleustein and independently of him, he discovered the existence in piezoelectrics of a new type of surface acoustic waves called "Bleustein-Gulyaev waves" in the world literature, which in some cases are more preferable for the practical use in comparison with known types of waves.

In 1979 Yu.V. Gulyaev was elected a corresponding member of the Academy of Sciences of the USSR, and in 1984 - full member (academician) of the USSR Academy of Sciences. Since 1992 Yu.V. Gulyaev is elected a member of the Presidium of the Russian Academy of Sciences. Yu.V. Gulyaev - President of the Russian Union of Scientific and Engineering Public Organizations, President of the Popov Russian Scientific and Technical Society of Radio Engineering, Electronics and Communications, president of the Prokhorov Academy of Engineering Sciences, one of the founders and full member (academician) of the Russian Academy of Natural Sciences, a foreign member of the Polish and Moldavian National Academies of Sciences, a foreign member of the Chinese Academy of Engineering Sciences, a member of the Advisory Scientific Council of the Development Fund for the Center for the Development and Commercialization of New Technologies in Skolkovo.

Yu.V. Gulyaev is the editor-in-chief of six prestigious domestic scientific journals (Radioengineering and Electronics, Radio Engineering, Biomedical Radio Electronics, Science in Technology and Industry, News of Higher Educational Institutions, Applied Nonlinear Dynamics, Journal of Radioelectronics), five of them which are included in the List of Higher Certification Comission (HAC) under the Ministry of Education and Science of the Russian

Federation, and a member of the editorial board of more than ten domestic scientific journals.

On the initiative of Yu.V. Gulyaev, are established branches of the Institute of Radioengineering and Electronics of RAS in Saratov and in Ulyanovsk, the Scientific Center of Electronic Diagnostic Systems of RAS (Center "Eldis", Moscow), the department of microelectronics technology of IRE, which later was separated into a separate Institute of Microwave Semiconductor Electronics of the Russian Academy of Sciences. Yuri Vasilievich was the director-organizer of the Institute of Nanotechnology of Microelectronics of the Russian Academy of Sciences. He is one of the organizers and the permanent header of the Saratov Scientific Center.

The contribution of academician Yu.V. Gulyaev in the development of science and technology was awarded of high prizes and awards: the European Physical Society Award (1979), the USSR State Prizes (1974, 1984), the State Prizes of the Russian Federation (1993, 2007) B.P. Konstantinov RAS (1991) Award, the Gold Medal to them. A.S. Popov of RAS (1995), as well as a number of orders and medals, including the Order of Merit for the Fatherland IV (1995) and III (1999) degree. Work Yu.V. Gulyaev are important for enhancing the country's defense capability and security, as evidenced by the USSR Council of Ministers' Prize in 1989, two Commendations of the Supreme Commander-in-Chief of the Armed Forces of the Russian Federation (2000, 2002) and the State Prize of the Russian Federation named after Marshal of the Soviet Union G.K. Zhukov in the field of military science (2013).

Yu.V. Gulyaev was one of the first to suggest and organize systematic studies of physical fields (thermal, microwave, optical, acoustic, chemical, etc.) at the Eldis Center and the characteristics of bioobjects and humans. Based on these studies, numerous methods and devices of early (usually non-invasive) medical diagnostics of the state of organs (heart, brain, lungs, mammary glands, etc.) and the entire human body were developed. Work to ensure traffic safety in railway transport using the developed diagnostic tools for the driver's condition, performed under the guidance and with the participation of Yu.V. Gulyaev, was awarded in 2012 the Prize of the Government of the Russian Federation.

Recently, Yu.V. Gulyaev is actively engaged in the development and research of new methods in biomedical radioelectronics, in particular, in human quasi-static tomography. On his initiative, an electrical impedance mammograph was developed for widespread use in personal medicine as a household appliance. The first results in electric field tomography are obtained. Under his leadership, the development of a fundamentally new method of targeted delivery of medicaments in the human body has begun. These results correspond to the world level or exceed it.

Currently, Yuri Vasilievich Gulyaev is the scientific director of Kotelnikov IRE RAS and the chairman of its Academic Council.

The fourth director of Kotelnikov IRE RAS - Corresponding Member of the Russian Academy of Sciences **SERGEY APOLLONOVICH NIKITOV**, occupies this post from 2014 to the present.

Dr. Sci. Phys-Math, Prof., Corresponding member of RAS Nikitov Sergey Apollonovich

Fig. 6. *Sergey Apollonovich Nikitov - director of V.A. Kotelnikov IRE RAS from 2014 to the present.*

- specialist in the field of solid-state micro- and nanoelectronics, solid state physics, computer science and the element component base [5].

Born April 23, 1955 in the city of Berdichev, Zhytomyr region, Ukrainian SSR. In 1979, he graduated from the Moscow Institute of Physics and Technology (Faculty of Physical and Quantum Electronics), in 1982 - his postgraduate studies with the defense of the dissertation of the candidate of technical sciences, since 1982 he has been working at the Kotelnikov Institute of Radioengineering and Electronics of RAS (Research Fellow, Senior Research Fellow), in 1991 he defended his thesis as a Doctor of Physical and Mathematical Sciences, since 1995 Professor, from 1991 to the present Head of the Laboratory of Magnetic and Optical Information Processing Methods, since 2003 Deputy Director for Science in IRE RAS.

May 22, 2003 he was elected Corresponding Member of the Russian Academy of Sciences on the Department of Informatics and Computer Systems of the RAS, since 2014 - Director of Kotelnikov IRE RAS.

Awards: 1981 - Komsomol Prize of the Moscow Region, 1984 - Lenin Komsomol Prize, 2009 - Russian Government Education Prize, 2010 - winner of the First competition of scientific megacities. In 1993-1994 he was a holder of a fellowship of the A. von Humboldt Foundation, the Ruhr University in Bochum, Germany, 1999 - a holder of a fellowship of the Landau-Volta Foundation (natural sciences), Rome, Italy.

Since 1985 S.A. Nikitov visited various universities as a senior researcher or as an invited specialist in various countries: England, France, Germany, Brazil, USA, Korea, Italy, Netherlands, Spain, Japan, Bulgaria, Poland, etc.

He was the organizer of several international meetings in various countries, in particular, he was the co-director of NATO ARW in Italy in 1995. Member of the Russian Physical and Magnetic Societies, Russian Academy of Engineering Sciences, IEEE, member of the Materials Research Society (USA), Vice-President of the Russian Section of the IEEE, member of the Popov Russian Scientific and Technical Society of Radioengineering, Electronics and Communications, Honorary Doctor of the University of Toulouse (France).

Member of the editorial boards of the journals "Radio Engineering and Electronics", "Nonlinear World", "Micro- and Nano-System Engineering.

S.A. Nikitov is the author and co-author of more than 400 scientific publications, incl. more than 170 articles in peer-reviewed scientific journals, co-author of 6 patents, co-author of books "The Newest Imaging Methods" (2008), "Shell fiber optic modes and long-period fiber gratings" (2012), "One-dimensional microwave photonic crystals"), more than 200 invited papers at international conferences and leading scientific centers around the world.

From 2007 to the present, Professor and Head Chair of Information Security of the Russian New University (RosNOU). In 2012, under his leadership, the Metamaterials laboratory was opened in Saratov Chernyshevsky State University.

Under his leadership, 15 candidate dissertations and 2 doctoral dissertations were defended. As an expert, he is a member of the Board of Directors of Unique Fiber Instruments LLC, the Russian Board of Reviewers of "Nanotechnology" Corporation, the Russian Foundation for Basic Research, the Council of Experts of the Information Technology Agency of the Russian Federation, the Board of Directors of "LLC Engineering Center".

For about 30 years he has been the head of research and R&D in the framework of research programs of the Russian Academy of Sciences, RFBR, the Ministry of Education and Science, the Ministry of Industry and Trade, the Ministry of Telecommunications and Informatics of the Russian Federation.

Sergey Apollonovich is the deputy chairman of the Scientific Council of the Russian Academy of Sciences on the problem of "Physics of Magnetic Phenomena", a member of the Scientific Council of the Russian Academy of Sciences on the problem of "Scientific foundations of building computing, telecommunication and location systems", of the RAS Commission for Working with Youth, he is a Scientific Secretary of the Presidium of the RAS Commission for the Improvement of the Structure of the Russian Academy of Sciences,

director of the Institute of Physics and Materials of the Saratov Chernyshevsky State University.

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