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## Preface

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## Overview of the International Conference on Metrological Support of Innovative Technologies – ICMSIT-2020

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**Abstract.** The overview describes the main directions and results of the International Conference “ICMSIT-2020” held in St. Petersburg in March 4, 2020. It gives the details about the participants and the proceedings. The anchor partner of Krasnoyarsk Science and Technology City Hall was St. Petersburg State University of Aerospace Instrumentation. A description of the main trends in modern innovative technologies, engineering and industrial physics as well as in the development of the second Forum “Metrological Support of Innovative Technologies” by the St. Petersburg State University of Aerospace Instrumentation is given in the overview.

The Volume contains Proceedings of the International Conference on Metrological Support of Innovative Technologies (ICMSIT-2020) which was held in March 4, 2020 in St. Petersburg, Russian Federation.

The purpose of the Conference was to share the results and prospects of the achievements in the application of modern methods of engineering physics and information-measuring technologies in high-tech production, in the fields of aerospace, energy, chemical and oil and gas engineering, economics and organization of engineering production, as well as in modern areas of complex research of technical and information systems.

The Conference “ICMSIT-2020” was jointly organised by the St. Petersburg State University of Aerospace Instrumentation and Krasnoyarsk Science and Technology City Hall with the support of the International and Russian Union of Scientific and Engineering Public Associations, UNESCO Departments of St. Petersburg and the Metrological Academy of the Russian Federation

The Program Committee and Editorial Board included prominent professors and scientists from the Russian Academy of Sciences, University of Maribor (Slovenia), Ruhr University in Bochum (Germany), St. Petersburg State University of Aerospace Instrumentation (Russia), Siberian Federal University (Russia) as well as specialists from Russian and foreign leading industrial enterprises.

A wide range of fundamental and applied problems of metrological support in various innovative technologies and systems has undergone consideration during the meeting.

The Conference was organised in 11 main directions:

- Engineering and Industrial Physics;
- Instrumentation Metrology and Standards;



- Control and Measurement Devices in Medicine;
- Measurements in Mechanical Engineering and Automation Systems;
- Innovative Technologies in Instrumentation and Electronics;
- Cybernetics, Economics and Organization of Metrological Support;
- Metrological Engineering and Support of Special Equipment;
- Advanced Tendencies of Training Specialists in Applied Physics, Engineering, and Metrology;
- Mechanical Engineering and Industry 4.0;
- Automation Engineering and Cyber-Physical Systems;
- Information-measuring systems for environmental monitoring.

The program of the Conference included keynote and plenary talks as well as numerous presentations of the participants (figure 1).



**Figure 1.** Plenary talks and sections.

The scientific session of the Conference was held at St. Petersburg State University of Aerospace Instrumentation (SUAI) in the framework of the second international forum “Metrological Support of Innovative Technologies”. The organization of the international forum belongs to the leadership of the St. Petersburg State University of Aerospace Instrumentation. For the first time on March 4, 2019, the I International Forum “Metrological Support of Innovative Technologies” was held, which was dedicated to the 75th anniversary of Academician of the Russian Academy of Sciences, Doctor of Economics, Professor, Head of the Department of Metrological Support of Innovative Technologies and Industrial Safety V.V. Okrepilov. The Metrological Academy of the Russian Federation, which has been under his leadership for several decades, has initiated this unique forum, which annually brings together hundreds of experts in the field of measuring equipment management, creating innovative product

quality control systems, and innovative training methods for specialists at the SUAI. The first forum was held on the basis of the Da Vinci Science and Exhibition Hall at St. Petersburg State University of Aerospace Instrumentation and gathered more than 50 speakers. It should be emphasized that scientists from Egypt, Slovenia, Thailand, Iraq, Belarus took part in the 1st forum. Thanks to Professor Okrepilov, scientists from one of the most authoritative scientific centers of Russia, the All-Russian Scientific Research Institute of Metrology named after D. I. Mendeleev, as well as many industrial enterprises, such as JSC NPO Radar-MMS, OJSC TsNPO Lenincts, LLC Regional Engineering and Technology Center of the city of Kaluga were invited to participate in the forum.

On March 4, 2020, SUAI hosted the II International Forum “Metrological Support of Innovative Technologies”, which was held under the auspices of the Unesco departments of St. Petersburg and the Russian Metrological Academy. The opening ceremony was attended by the President of the Metrological Academy of the Russian Federation, academician of the Russian Academy of Sciences, doctor of economic sciences, professor V.V. Okrepilov, head of D.I. Mendeleev VNIIM, Academician of the Metrological Academy of the Russian Federation A.N. Pronin, deputy Director of D.I. Mendeleev VNIIM in quality and educational activities, Doctor of Technical Sciences, academician of the Metrological Academy of the Russian Federation M.V. Okrepilov, Director of the Institute of Physics and Technology of SUAI Doctor of Technical Sciences, Professor E.G. Semenova, as well as a representative of the Indian scientific community, a research fellow at Amity University, PhD, Saurav Dixit (India, Delhi).

Greetings to the forum participants from the Chairman of the Organizing Committee of the II International Forum, Rector of SUAI, Doctor of Economics, Professor Yu. A. Antokhina included a call for collaborations, the expansion of international relations, and the deepening of scientific knowledge: “With the development of the economy and industry, with the advent of new high-tech tools and technologies at domestic enterprises, it is important not to forget that quality management methods must also keep pace with the times, and access to foreign markets is impossible without meeting international standards. Innovations require the development of advanced measuring instruments that facilitate the introduction of new and improvement of previous technological processes”.

Discussion of the development of high-tech industry and improving the quality of industrial production within the framework of the II international forum “Metrological support of innovative technologies” made it possible to draw up an accurate picture of scientific activity in this area. Interest in metrology is increasing in the modern world, which was clearly shown by the first forum held by the St. Petersburg State University of Aerospace Instrumentation in 2019. This year, the geography of participants is expanding significantly. The forum was joined by experts from India, Egypt, Poland, Belarus, Kazakhstan, the United Kingdom of Great Britain and Northern Ireland, Latvia and Iran.

The event has offered a platform for bringing together students, postdocs, innovative academics and industrial experts to exchange their ideas and contribute new engineering approaches to metrological support of mechanical and automation processes in various technological-, information-, measuring systems for environmental monitoring. Great interest was aroused by the section devoted to cybernetics, economics and organization of metrological support, advanced tendencies of training specialists in applied physics, engineering, and metrology, instrumentation metrology and standards.

The Conference provided the premier interdisciplinary and multidisciplinary forum for researchers, practitioners and educators to present and discuss the most recent innovations, trends, concerns, practical challenges encountered and the solutions adopted in the fields of innovative technologies in instrumentation and electronics, mechanical and automation engineering, chemical technologies, cyber-physical systems, digitization of Industry 4.0, etc. Although the schedule of the Conference was very tight, there were very vivid discussions among the participants.

All speakers made presentations demonstrating a high level of professional training. The sections devoted to metrology in the field of medicine, innovative technologies in measurements, pedagogical problems of personnel training, military subjects and ecology allowed to unite the maximum number of participants. The participants who could not come to the Conference due to different reasons including

the problem of high transportation costs presented on-site presentations which are available on the website of the Conference.

The reports of participants representing leading research institutes, manufacturing companies, universities and educational centers of Russia, Europe and Asia aroused great interest. As part of the in-person session of the conference, postgraduate students and faculty of Tambov State Technical University, Belgorod State University, Siberian Federal University, Penza State University, South-West State University (Kursk), Dagestan State Medical University, University of Dubna presented their work (Dimitrov, Moscow region), Joint Institute for Nuclear Research (Dubna), St. Petersburg Mining University, St. Petersburg State University of Industrial Technology and Design, Leningrad State University, A.S. Pushkin, St. Petersburg State Marine Technical University, Baltic State University "Voenmekh" and other universities. Presentations on innovative technologies from companies were presented: NPP Radar MMS JSC, KRONE-Engineering LLC, Lot Research Institute Krylov State Scientific Center, Test-S.-Petersburg, Klimov UEC, FSUE "VNIIM named after D.I. Mendeleev."

At the end of the forum, an Olympiad was held devoted to the history of the development of aviation technologies. The victory in the Olympics was won by an international team consisting of university students from Russia and a scientist from India.

The international scope of the Conference was confirmed by the participation of representatives from 11 countries besides Russia (China, Vietnam, Spain, Republic of Tajikistan, Uzbekistan, Republic of Kazakhstan, Kyrgyzstan, Switzerland, UAE, Morocco, Ukraine):

- China Aviation Industry General Aircraft Zhejiang Institute Co., Ltd, China
- Vietnam Maritime University, Hai Phong, Vietnam
- University of Cadiz, Puerto Real, Spain
- The Technological University of Tajikistan, Dushanbe, the Republic of Tajikistan
- Tashkent institute of irrigation and agricultural mechanization, Tashkent, Uzbekistan
- Tashkent State Technical University named after Islam Karimov, Uzbekistan
- Tajik State University of Commerce, Dushanbe, the Republic of Tajikistan
- Tajik State Finance and Economics University, Dushanbe, Republic of Tajikistan
- International Kazakh-Turkish University, Republic of Kazakhstan
- Kazakh University Ways of Communications, Republic of Kazakhstan
- Shenzhen MSU – BIT University, Shenzhen, China
- Samarkand branch of Tashkent University of information technologies named after Mukhammad al-Khwarizmi, Samarkand, Uzbekistan
- People's Police Academy, Hanoi, Vietnam
- Navoi State Mining Institute, Navoi, Uzbekistan
- M. Kozybayev North Kazakhstan State University, Petropavlovsk, Kazakhstan
- Kyrgyz National Agrarian University named after K I Scriabin, Bishkek, Kyrgyzstan
- Kyrgyz State Technical University, Bishkek, Kyrgyzstan
- Karakalpak State University, Nukus, Uzbekistan
- Institute of Mechanics and Seismic Stability of Structures of the Academy of Sciences of the Republic of Uzbekistan, Tashkent, Uzbekistan
- Institute of Polymers, Department of Materials, Switzerland
- Branch of the National University of science and technology «MISiS» in Dushanbe, Dushanbe, the Republic of Tajikistan
- Bukhara engineering-technological institute, Bukhara, Uzbekistan
- Al Ain University, Abu Dhabi, UAE
- Abdelmalek Essaâdi University, Tangier, Morocco
- Donetsk National Technical University, Donetsk, Ukraine

In the future, the forum organizing committee plans to further develop international cooperation and attract foreign countries in order to expand the geography of participants. The plans include bringing to

work in a forum of scientists the International Bureau of Weights and Measures - the main organization in the world that is involved in measurements, as well as the inclusion of Nobel Prize winners in the organizing committee of scientists.

The participants from Russia (more than 50 regions) represented about 200 universities, scientific institutes and organisations, industrial enterprises:

- A.O. Kovalevsky Institute of Biology of the Southern Seas of RAS (IBSS), Sevastopol
- Academy of the Investigative Committee of the Russian Federation, Moscow
- All-Russian research Institute of hydraulic engineering and land reclamation. A. N. Kostyakova, Moscow
- Altai State Technical University, Barnaul
- Altai State University, Barnaul
- Altay State Agricultural University, Barnaul
- «OKB ZENIT», Krasnoyarsk
- Baltic state technical university «VOENMEH», Saint Petersburg
- Bauman Moscow State Technical University, Moscow
- Belgorod State Technological University named after V.G. Shukhov, Belgorod
- Bolhov Plant of semiconductor devices, Bolhov
- Center of Information Technologies and Systems for Executive Power Authorities (Federal state Autonomous Research Institution), Moscow
- Central Research Institute of Economy, Management Systems and Information, Moscow
- Chechen State Pedagogical University, Grozny
- Grozny State Oil Technical University named after Academician M. D. Millionshchikov, Grozny
- Chechen State University, Grozny
- Chuvash State Agricultural Academy, Cheboksary
- Chuvash State University, Cheboksary
- Daghestan State Technical University, Makhachkala
- Federal State Budgetary Scientific Institution «Institute of Experimental Medicine»
- Moscow State Linguistic University, Moscow
- Bryansk State Engineering Technological University, Bryansk,
- Bryansk State Agrarian University, Bryansk
- Department of state analytical control of the Republic of Bashkortostan, Ufa
- Ural State Forest Engineering University, Ekaterinburg
- Don State Technical University, Rostov-on-Don
- ElseTech, Krasnoyarsk
- Federal Research Center "Krasnoyarsk Science Center of the Siberian Branch of the Russian Academy of Sciences", Krasnoyarsk
- L.V. Kirensky Institute of Physics SB RAS, Krasnoyarsk
- Federal state budgetary educational institution of higher education "Khakassia state University named after N. F. Katanov", Abakan
- Federal State Budgetary Institution "Central Black Earth UGMS", Kursk
- Financial University under the Government of the Russian Federation, Moscow
- Grozny International University LLC., Grozny
- Gubkin Russian State University of Oil and Gas, Moscow
- Institute for Problems of Ecology and Mineral Wealth Use of Tatarstan Academy of Sciences, Kazan
- Institute of Astronomy of the Russian Academy of Sciences, Moscow
- Institute of Chemistry and Chemical Technology SB RAS,
- Institute of Computational Modeling SB RAS Krasnoyarsk,
- Institute of Technical Chemistry of Ural branch of Russian Academy of Sciences, Perm
- Irkutsk National Research Technical University, Irkutsk
- Irkutsk State Agricultural University named after A.A. Ezhevsky
- Irkutsk State Transport University, Irkutsk
- Iskra Innovation, Research and Technology Center OJSC, Ufa
- ITMO University, Saint Petersburg
- JSC "SERVET-M", Moscow
- JSC "NPP "Compensator"

- JSC "Special Design Bureau of the Moscow Energy Institute", Moscow
- JSC "NPO VEI Electroizolyatsia", Moscow
- JSC «Special Design Bureau of the Moscow Power Engineering Institute», Moscow
- JSC Academician M.F. Reshetnev Information Satellite Systems, Zheleznogorsk, Krasnoyarsk region
- K.G. Razumovsky Moscow State University of technologies and management (the First Cossack University), Moscow
- Kabardino-Balkarian state agricultural university named after V.M. Kokov, Nalchik
- Kazan Federal University, Kazan
- Kazan National Research Technical University named after A.N. Tupolev – KAI (KNRTU-KAI), Kazan
- Kazan State Power Engineering University, Kazan
- Kirov State Medical University, Kirov
- Krasnoyarsk Public Medical University named after professor V.F. Voyno-Yasenetsky, Krasnoyarsk
- Krasnoyarsk State Agrarian University, Krasnoyarsk
- Kuban State Agrarian University named after I.T. Trubilin, Krasnodar
- Kursk State Agricultural I.I. Ivanov Academy, Kursk
- Kursk State University, Kursk
- Lomonosov Moscow State University, Moscow
- Magazine "Standards and Quality", Moscow
- Mechanical Engineering Research Institute, Russian Academy of Sciences, Moscow
- Mendeleev University of Chemical Technology of Russia, Moscow
- Michurinsk State Agrarian University, Michurinsk
- Military Institute (engineering) of the Military Academy logistics support named after Army General A. V Hrulev
- Saint Petersburg Mining University, St. Petersburg
- Minin State Pedagogical University of Nizhny Novgorod
- MIREA - Russian Technological University, Moscow
- Moscow Aviation Institute (National Research University), Moscow
- Center of Information Technologies in Engineering RAS, Odintsovo
- Moscow City University, Moscow
- Moscow international University MGIMO, Moscow
- Moscow Polytechnic University, Moscow
- Moscow Power Engineering Institute (MPEI), Moscow
- Moscow State University of Civil Engineering, Moscow
- Moscow State University of Geodesy and Cartography, Moscow
- Moscow Technical University of Communications and Informatics, Moscow
- Moscow Technological Institute, Moscow
- National Research Irkutsk State Technical University, Irkutsk
- National Research Technological University, Kazan
- Nizhnekamsk Institute of Chemical Technology (branch) of the Kazan National Research Technological University, Nizhnekamsk
- Nizhny Tagil Institute of Technology (branch) Ural Federal University named after the first President of Russia B.N. Yeltsin, Nizhny Tagil;
- North-Caucasian Institute of Mining and Metallurgy (State Technological University)
- North-Eastern Federal University, Yakutsk
- Nosov Magnitogorsk State Technical University
- Novokuznetsk Branch-Institute of Kemerovo State University, Novokuznetsk
- Omsk State Agrarian University, Omsk
- Omsk State Technical University, Omsk
- Omsk Tank-automotive Engineering Institute, Omsk
- Orel State University named after I.S. Turgenyev, Orel
- PLC SYSTEM Ltd, Moscow
- Penza State University, Penza
- Penza State Technological University, Penza
- Perm Military Institute of National Guard Troops of the Russian Federation
- Perm National Research Polytechnic University, Perm
- Perm State Agrarian-Technological University named after academician D N Prianishnikov

- Petrozavodsk State University, Petrozavodsk
- Plekhanov Russian University of Economics, Moscow
- Pskov State University, Pskov
- Research Institute of automated means of production and control, Voronezh
- Research Institute of the Federal Penitentiary Service of Russia, Moscow
- Research Institute of the Military Academy of Material and Technical Support named after Army General A.V. Khrulev,
- Reshetnev Siberian State University of Science and Technology, Krasnoyarsk
- Rostov State University of Economics, Taganrog
- Metrological Support of Innovation Technologies and Industrial Security Department of the Russian Academy of Sciences, St. Petersburg
- Institute of Amelioration, water management and construction named after A.N. Kostyakov, Moscow
- Russian State Agrarian University – Moscow Timiryazev Agricultural Academy
- Russian State Social University, Moscow
- Russian State University for the Humanities, Moscow
- Russian Technological University, Moscow
- Russian University of Transport, Moscow
- Russian Water and Wastewater Association, Moscow
- MIREA – Russian Technological University, Moscow
- Technical Committee for standardization TC 343 «water Quality» Rosstandart, Moscow
- Saint Petersburg Mining University, Saint Petersburg
- Saint Petersburg State Electrotechnical University, St. Petersburg
- Center for Regional Problems of Quality Economics Institute for Problems of Regional Economics, RAS, St.-Peterburg
- D.I. Mendeleev State Institute for Metrology
- Saint Petersburg State University of Aerospace Instrumentation, Saint Petersburg
- Military Space Academy named after A F Mozhaysky of the Ministry of Defense of the Russian Federation, St. Petersburg
- Enterprise “Radar MMS”», Saint-Petersburg
- JSC “Concern “OKEANPRIBOR””, Saint-Petersburg
- St. Petersburg Institute for Informatics and Automation of the Russian Academy of Sciences, St. Petersburg
- Peter the Great St. Petersburg Polytechnic University, Saint-Petersburg
- S. M. Budjonny Military Academy of the Signal Corps, Saint-Petersburg
- Samara State Agrarian University, Kinel
- K.G. Razumovsky Moscow State University of technologies and management, Moscow
- Samara University, Samara
- Saratov State Vavilov Agrarian University, Saratov;
- Shternberg State Astronomical Institute of Lomonosov Moscow State University, Moscow
- Shukshin Altai State University for Humanities and Pedagogy, Biysk
- Sevastopol State University, Sevastopol
- Siberian Federal University, Krasnoyarsk;
- Siberian Fire and Rescue Academy of the State Firefighting Service of the Ministry of Civil Defence, Emergency Situations and Natural Disaster Response of the Russian Federation, Zheleznogorsk
- South Ural Institute of Management and Economics, Chelyabinsk
- Southwest State University, Kursk
- St. Petersburg State University of Economics, St. Petersburg
- North Caucasus Federal University
- Admiral S.O. Makarov State University of the Sea and River Fleet, St. Petersburg
- State University of Forestry and Technologies named after G.F. Morozov, Voronezh
- State University of Management, Moscow
- Stock Company «Experimental Design Bureau «Electroavtomatika» named after P A Yefimov, Saint Petersburg
- Surgut State University, Surgut
- Federal scientific center Research Institute for system research of the Russian Academy of Sciences, Moscow
- Tambov State Technical University, Tambov
- Tsvilsky agricultural engineering College of the Ministry of education of Chuvash Republic, Tsvilsk



- The branch of JSC «FGC UES» Krasnoyarsk enterprise MES Siberia, Krasnoyarsk
- The Institute of Molecule and Crystal Physics at the Ufa Research Center of the Russian Academy of Sciences, Ufa
- Togliatti State University, Togliatti
- Tuva State University, Kyzyl
- Tver State Technical University
- Ufa State Aviation Technical University (USATU), Ufa
- Ufa State Petroleum Technical University, Ufa
- Ulyanovsk State Technical University
- University of the Inter-Parliamentary Assembly of the Eurasian Economic Union, St. Petersburg
- Ural Federal University named after the first President of Russia B.N. Yeltsin, Yekaterinburg
- Ural Institute of State Fire-Prevention Service of the Ministry of Emergency, Ekaterinburg
- Voronezh Institute of Russian Federal Penitentiary Service, Voronezh
- V. A. Trapeznikov Institute of Control Sciences of Russian Academy of Sciences, Moscow
- V.I. Vernadsky Crimean Federal University, Simferopol, Republic of Crimea
- Volga State University of Technology, Yoshkar-Ola
- Volgograd State Agricultural University, Volgograd
- Volgograd State Technical University, Volgograd
- Branch of LUKOIL-Engineering Volgograd
- Volzhsky Polytechnic Institute (branch) of the Volgograd State Technical University, Volzhsky, Volgograd Region
- Voronezh Institute of Russian Federal Penitentiary Service, Voronezh
- Voronezh State University of Forestry and Technologies named after G.F. Morozov, Voronezh
- Vyatka State Agricultural Academy, Kirov
- Vyatka State University, Kirov
- Yakut State Agricultural Academy, Yakutsk
- Yuri Gagarin State Technical University of Saratov, Saratov

All participants were invited to present their papers in this Volume and all submitted manuscripts went through the independent peer review process. We are very grateful to all reviewers from Russia, China, USA, Slovenia, Germany and Republic of Kazakhstan for their time and highly professional comments. We deeply believe that their reviews gave opportunity to improve the scientific quality of the presented papers which may be useful for academic, scientific and industrial partners.

More than 500 reports were submitted to the Organizing Committee of the Conference. 367 reports were selected for inclusion into this Volume after the review process. All the papers were subjected to rigorous peer-review by conference committee members and international reviewers. The papers were selected based on their quality and relevance to the Conference directions and on the results of their presentation at the Conference session. The proceedings present to the readers the recent advances in the field of applied physics and cyber-physical systems (section 1), cybernetics, economics and information measuring systems (section 2), engineering and innovative technologies (section 3), instrumentation technologies and environmental engineering (section 4). These papers reflect modern engineering approaches in all Conference directions, broaden the researches of the previous Conferences [1-6].

We chose the Journal of Physics: Conference Series (JPCS) to provide all contributors with the opportunity to publish their papers in an international, peer-reviewed journal. This is understood and appreciated by all the participants of our Conference, and therefore this Volume provides an excellent overview of the main topics of our Conference.

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We highly appreciate the great work of the conference organizers, which included the invitation of the speakers, preparation of the program and abstract book, conference banner, as well as coordination of the in-person session in St. Petersburg. The main part of this work was performed by the members of the organizing committee: Doctor of Technical Sciences, professor, Director of the Institute of FPTI GUAP E. G. Semenova, Ph.D., associate professor of the Institute of FPTI GUAP M. S. Smirnova and Ph.D., Associate Professor of the Institute of FPTI GUAP K.V. Epifantsev.

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