Skolkovo Institute of Science and Technology

Skoltech Annual Report





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SKOLTECH ANNUAL REPORT 2020



It was the most extraordinary and challenging year, one that tested the world and each of us. I am especially proud of the way Skoltech responded to the challenges of the pandemic. From the very beginning, our faculty conducted research, advised the government, explained - and thus gave hope to society on various aspects of the pandemic. Almost 100,000 face shields were engineered by the FabLab and assembled by the Skoltech community - to protect medical staff struggling with the pandemic in red zones. Thanks to investments in digital capacity, but mostly because of our incredible faculty, students and staff, we moved such core processes as teaching, learning, and operations online, adjusting to virtual meeting rooms and finding ways to connect while working from home. In times of great uncertainty, we have neither lost sight of our purpose nor wavered from our commitment. As a participant of the National Technology Initiative, Skoltech designed and delivered a few technologies. Jointly with MTS, a national telecom giant, we piloted a 5G network in Skolkovo based on our own software – a project to ensure technology competitiveness and enable state-of-the art applications.

Advancing the partnership with Sber, Skoltech Founder and a long-lasting partner, we launched a project to create an ecosystem for development and integration of medical applications using AI technologies. The year was also marked with a milestone: 1000 top level graduates capable of working in a rapidly changing global landscape, future leaders in science, technology and business completed their studies at Skoltech. It is also important that we recruited a new cohort of students. not compromising the level of the incoming class, thanks to successful transfer of our outreach and recruitment campaign to the online mode.

After a long break and despite market turbulence, Skoltech endowment received a generous donation from Sber for academic development programs. 2020 gave us a chance to review our current standing and define aspirations for the future. We are entering 2021 with a new strategy: the future is full of goals and endeavors, and I look forward to this.

Sincerely, Alexander Kuleshov



Strategic development

About Skoltech

Skoltech was established in 2011 in collaboration with MIT with the vision of being a world-leading institute of science and technology. Skoltech mission is to impact economy and society development based on academic and technology excellence and entrepreneurial spirit. The strategic programs of the Centers, which are the core units, advance Skoltech research, education and innovation agenda in six priority areas – Data Science and Artificial Intelligence, Life Sciences and Health, Cuttingedge Engineering and Advanced Materials, Energy Efficiency, Photonics and Quantum Technology, Advanced Studies.

Research accomplishments in select areas have been recognized as world-class, bringing Skoltech to the list of top-100 world's leading young universities in prestigious Nature Index ranking (2019). The research portfolio is funded through Skolkovo Foundation grant, also national and international grant programs. Skoltech was awarded 6 EU HORIZON grants and 5 national grants to create world level labs in the most promising areas from scratch.

The educational offering of 10 MSc and 7 doctoral programs attracts talented and motivated students from Russia and the world: in 2020 Skoltech received almost 18 000 applicants from 170 countries. For three years in row, Skoltech evidences a high competition rate: only 2% of applicants, going through a multiple stage merit-based selection, are enrolled.

R&D Centers specializing in Wireless Technologies and IoT, Wireless Communication Technologies and 6 Joint Labs with high-tech companies develop, prototype and facilitate scaling of cutting-edge technology solutions. Overall, in 2020, Skoltech researchers conducted almost 350 projects totaling 1.9 bln Rub. 2 bln Rub have been committed for the coming years.

The launch of 5G pilot zone based on Skoltech software and the start of creating AI-based healthcare ecosystem jointly with Sber, Skoltech Founder and a strong partner, are remarkable achievements of 2020. Since 2011, Skoltech students, faculty and alumni founded dozens of enterprises in Russia and abroad, 57 startups received Skolkovo residency. Internationally recognized campus located in Skolkovo is a home for a vibrant multicultural community of 147 faculty, 520 researchers and engineers, 1068 students, 404 staff members. 1017 alumni are spread in Russia and globally, being employed in top companies, research centers or continuing for PhD at Skoltech or world leading universities.

Governance and management

Governing bodies supporting strategic development

Skoltech governance framework is presented by the General Founders Meeting, Board of Trustees, Academic Council, and the President. The governing bodies act on the basis of Russian legislation, Charter, Regulations.

The General Founders Meeting is the highest governing authority, empowered to approve the Charter, make decisions on Skoltech participation in legal entities, appoint Board of Trustees and the President. The principal resolutions included approval of Skoltech co-founding the New League of Universities¹, establishment of Alumni Association, appointments of Board of Trustees members - Simon Bradley, Founder & CEO of Percent-Edge, and Johann Füeller, CEO of **HYVE AG Innovation Agency** and Professor at the University of Innsbruck. In December, the Founders unanimously appointed Alexander Kuleshov as the President for the second term of office, and endorsed the Strategy 2021 - 2025 presented by the President.

In addition to the governing role, the Founders contributed to Skoltech in other aspects. Sber made a 100 mln Rub donation to endowment for student development, building alumni community, co-financing of applied research projects. The National Economic School is chairing development of the methodology to measure Skoltech economic impact, which is a key indicator of the new Strategy.

The Board of Trustees oversees Skoltech strategic development and financial standing, reviews proposals and plans on major strategic vectors. During the year the Board approved Skoltech annual reporting, budget 2021 – 2023, a proposal on student development framework, plans for building alumni community and fundraising. After wide discussions on the strategy concept, the Board approved the Strategy 2021 -2025, making recommendations on key indicators and certain strategic directions. Also, the Board appointed Viktor Vekselberg as the Chairman, and Arkady Dvorkovich as the Chair of the Executive Committee.

¹ The association of Skoltech, National Economic School, Moscow School of Social and Economic Sciences, European University at St. Petersburg.



Board of Trustees membership (as of March 1, 2021)



Viktor Vekselberg Chairman of the Board Member of Skolkovo Foundation Board of Directors. Chairman of Renova Group Board. Board member since 2011



Alexander Abramov Chair of the Board of Directors of EVRAZ. Board member since 2012



Simon Bradley Founder & CEO of Percent-Edge. Board member since 2020



Tony F. Chan President of King Abdullah University of Science and Technology. Board member since 2016



Edward Crawley Ford Professor of Engineering at Massachusetts Institute of Technology. Skoltech Founding President. Board member since 2011



Arkady Dvorkovich

Chairman of the Skolkovo Foundation. Chair of the Executive Committee of the Board. Board member since 2014



Johann Füller CEO of HYVE AG Innovation Agency, Professor at the University of Innsbruck. Board member since 2020



Alexander Galitsky

Co-Founder of Almaz Capital. Board member since 2014



Andrey Ivanov First Deputy Minister of Economic Development

of the Russian Federation. Board member since 2016



Valery Katkalo First Vice Rector, Higher School of Economics. Board member since 2016



Oleg Kharkhordin Professor, Political Science Department, Director, Center "Res Publica", European University in Saint-Petersburg. Board member since 2016



Nikolay Kudryavtsev Rector of Moscow Institute of Physics and Technology. Board member since 2012



Alexander Kuleshov Skoltech President. Board member since 2012



Richard Lester Associate Provost, Massachusetts Institute of Technology. Board member since 2016



Alexander Povalko CEO of RVC. Board member since 2013



Alexey Repik Chairman of the Board of "R-Pharm" JSC. Board member since 2016



Chris Skirrow

Former partner at PwC. Chair of the Audit Committee of the Board. Board member since 2013



Paul Thompson Professor, Keck School of Medicine, USC. Board member since 2016



Pekka Viljakainen Chairman of the Board of Directors of Skolkovo Ventures. Board member since 2016

Academic Council membership (as of March 1, 2021)



Professor Alexander Kuleshov Chairman, Skoltech President



Professor Iskander Akhatov Center for Design, Manufacturing and Materials



Professor Nikolai Brilliantov Center for Computational and Data-Intensive Science and Engineering



Professor Edward Crawley Ford Professor of Engineering at MIT. Skoltech Founding President



Professor Maxim Fedorov VP Artificial Intelligence and Mathematical Modelling



Professor Clement Fortin Associate Provost, Dean of Education



Professor Anton Ivanov Space Center



Professor Ildar Gabitov Center for Photonics and Quantum Materials



Dr. Grigory Kabatiansky Advisor to the President for Science



Professor Mikhail Gelfand VP Biomedical Research

Professor

Provost

Keith Stevenson



Professor Dmitry Kulish Center for Entrepreneurship and Innovation



Professor Igor Krichever Center for Advanced Studies

The Academic Council is a principal governing body to oversee Skoltech educational, scientific, R&D and innovation activities. In 2020, the Council and Committees revisited approaches for managing the Centers and research facilities, provided inputs on policies for student admission, final state attestation, thesis defense. The Appointment, Promotion and Tenure Committee reviewed more than 200 cases, as well as 30 nominations of the academic staff to awards. The Research and Innovation Committee approved the plans of the shared facilities, purchase requests for research equipment, grant reports.



Dr. Alexander Fertman Director on Science and Education, Skolkovo Foundation



Ekaterina Malysheva Representative of alumni



Alexey Ponomarev Senior VP Industrial Cooperation



Professor Valery Rubakov Moscow State University



Dr. Alexander Safonov VP Development



Professor Mikhail Spasennykh Center for Hydrocarbon Recovery



Lawrence Stein VP International Business Affairs, IP



In 2020, when 'online', 'remote' and 'digital' were gaining momentum across the globe, Skoltech shared governance system appeared to be ready for distant operation. In the atmosphere of dialogue, the Academic Council and its committees conducted 35 meetings, more than in any other year, with almost 100% of presence, to ensure a balanced view on the strategy planning, policy making, faculty hiring, teaching & learning.

Alexander Safonov, Vice President for Development, Academic Secretary

Towards the Strategy 2021 – 2025

In the light of approaching the 10th anniversary of Skoltech establishment. also end of the strategy period (2018 – 2020), Skoltech leadership launched a planning initiative to define directions for development on a five years horizon. The planning cycle, lasting over 10 months, was opened with SWOT, made by the Centers and administration. Further, the task force of senior management, CREI Directors, heads of departments, representatives of the Academic Council, Board of Trustees defined a concept to lay a basis for the Strategy 2021 - 2025. The thread running through the Strategy 2021 – 2025 is Targeting Excellence Today to Impact Tomorrow. To become a full-fledged world-class institute of science and technology, which makes a substantial economic impact, Skoltech will target the highest level of research, emphasize scaling of results, and become

a recognized national 'think' and 'act' tank in priority technology areas. No less important will be operational excellence enabling a favorable environment for students and staff. At the end of year, President Alexander Kuleshov introduced the core messages of the Strategy to Skoltech community during the online Town Hall.

Focusing agenda of the target domains

The assessment of Skoltech standing in the target domains is conducted every two years through an independent review of the Centers. The assessment 2020 focused on Centers' results 2016 – 2020, also further plans. The international review panels indicated topical areas of excellence and international visibility, strong collaborations, relevance of the educational programs to the target domains. The reviewers also provided



Skoltech's potential should serve to attain national development goals and improve the quality of life in Russian cities. Modern digital technology brings a breakthrough in urban services and entrepreneurship.

Igor Shuvalov, Chairman of VEB.RF, Chairman of Skolkovo Foundation Board of Directors recommendations on the research agenda and ways to improve the educational offering.

Lab construction moving forward

The lab construction program was implemented as planned. The Center for Entrepreneurship and Innovation and the Center for Computational and Data-Intensive Science and Engineering received new facilities on the campus. The construction of the library, a focal point of intellectual environment, was completed – Skoltech community received multifunctional spaces for individual and group work.

Executive leadership appointments and organizational structure

The changes in the executive team included appointment of Alexey Ponomarev as the Senior VP Industrial Cooperation, Professor Maxim Fedorov as VP for Artificial Intelligence and Mathematical Modeling and Professor Mikhail Gelfand as VP for Biomedical Research. Clement Fortin was appointed as Associate Provost, Dean of Education.

The unprecedented challenge of the pandemic was faced by the COVID response team, chaired by Provost. Committed to safety and health of students and staff, the team ensured emergency measures, coordinated Skoltech transfer to the online mode, designed a recovery plan for a gradual return to campus. The COVID hot line was organized to support staff and students.

The organizational level changes included renaming of the Center for Neurobiology and Brain Restoration to the V. Zelman Center for Neurobiology and Brain Restoration, establishment of the Research Facilities Center, Finance and Administration Department, fundraising and marketing functions in the Strategic Communications Department.



We are deeply interested in and wish to be a part of the advanced development of Skoltech as one of the country's innovation hubs. Sber appreciates the application-focused approach underlying the Skoltech Strategy 2021–2025 which can become a powerful driver for high technology entrepreneurship in Russia.

Herman Gref, CEO, Chairman of the Executive Board of Sber

Advisor for Construction Simonov Andrey Security Campus Security Management Operational Internal Control Operations Zakharova Administration Finance & Tatyana **Procurement** Finance & Legal ٩ ¥ ╘ Int. Business Affairs, IP Lawrence Stein ٩ Academic Excellence and Value Generation Alexander Kuleshov Modeling Maxim Fedorov **President** Trustees Mathematical VP Biomedical Board **Keith Stevenson** Research Research Initiatives **Research Facilities** Gelfand VP AI & Mikhail Provost Education Centers Industrial Programs Cooperation Industry Liaison Ponomarev R&D Contacts **Senior VP** Industrial STD Analysis Alexey Academic <u>Organizational</u> Council Development **Organizational Development** Student Affairs Alexander **Strategic Governance and** Development Institutional Safonov ٩ Communications and Community chart Development Communications Sitnikov Alexey ٩





Human capital

Academic and non-academic staff

World-class research requires top qualified personnel capable to work across the boundaries to produce outstanding results. Skoltech maintains the highest standards for hiring and promotion allowing to have high-level research groups led by internationally known faculty. Appointments and promotions of 2020 were made to strengthen research, education and innovation performance in a number of areas.

New faculty hires

Skoltech made investments to recruit talents in the areas of strategic importance and was successful in attracting faculty from international markets, which is an evidence of a growing international reputation. Based on review of the candidates' qualification and plans to contribute to the Centers, the Academic Council Appointment, Promotion and Tenure Committee made the following appointments:



The mission of the Committee is to ensure the highest quality standards to faculty, which are aligned with the ambitious goals declared by Skoltech while establishment. In 2020, the Committee reviewed 28 competition cases, almost half of which directly referred to Skoltech future – young faculty and researchers. The pandemic influenced the Committee operations: the majority of cases included contract renewals and promotions of young researchers who have always been given the Committee attention. Skoltech has the "promotion roadmap" which defines terms under which a young researcher can receive promotion. But in exceptional cases, the Committee is flexible and can bend the rules if there is a strong justification. This was exactly the case of Professor Georgii Bazykin whom the Committee unanimously promoted to Full Professor in 2020. No one even bothered to check whether we complied with the roadmap or not.

Professor Igor Krichever, Chair of the Appointment, Promotion and Tenure Committee of the Academic Council



Mikhail Lebedev Full Professor, V.Zelman Center for Neurobiology and Brain Restoration. Research expertise in neurophysiology and brainmachine interfaces, main contributions are in motor control and electrocorticography in human neurophysiological functions of the cerebral cortex and basal ganglia, bidirectional neural prostheses. Previous affiliation: Duke University Center for Neuroengineering, USA



Cecile Ben Associate Professor, Digital Agro Laboratory. Research expertise in plant genetics and breeding, biotechnology.

Previous affiliation: Agro Toulouse (INP ENSAT), France



Dmitry Kolomenskiy Assistant Professor, Center for Design, Manufacturing and Materials. Research expertise in fluid– structure interaction, numerical modelling, high performance computing, adaptive methods, machine learning.

Previous affiliation: Tokyo Institute of Technology, Japan



Loic Salles Assistant Professor, Center for Design, Manufacturing and Materials. Research expertise in advanced system analysis and design, computational vibration to develop numerical techniques for analysis of vibration of large-scale model taking into account the non-linearities. Previous affiliation: Vibration University Technology Center, UK

Awards and professional recognition

The year brought a number of national and international awards and professional appointments. The Provost, Professor Keith Stevenson received the Charles N. Reilley Award of the Society for Electroanalytical Chemistry. Professor Artem Oganov was elected as Fellow of the Royal Society of Chemistry and a Fellow of the American Physical Society. Professor Evgeny Burnaev received The Ilya Segalovich Award (Yandex) as the best academic advisor. Professor Ivan Oseledets was appointed to the Russian Presidential Council for Science and Education. For a few years in a row, the Moscow **Government Award for Young Scientists** went to Skoltech: the winners 2020 are

Dr. Alexander Kvashnin (Physics and Astronomy category), Professor Victoria Nikitina, Professor Stanislav Fedotov, and Dr. Dmitry Aksenov (Chemistry and Materials Science category), Dr. Yuri Yanovich (Data Transfer, Storage, Processing and Protection category). Dr. Dmitri Krasnikov was awarded with Zhores Alferov scholarship for achievements in designing new lowdimensional materials. The traditional Skoltech Teachina Award went to the faculty demonstrated excellence: Professor Tatvana Podladchikova (Best Professor), Professor Victor Lempitsky (Best Instructor), Professor Dmitry Dylov (Best Supervisor), Professor Dmitry Kulish (Best Career Trainer), Professor Albert Nasibulin (Best Mentor).







Left to right: Professor Tatyana Podladchikova, Professor Victor Lempitsky, Professor Albert Nasibulin, Professor Dmitry Dylov, Professor Dmitry Kulish

Faculty assessment

The annual faculty assessment was organized by the Provost Office in the format of self-evaluation. The asessment criteria considered faculty research output, educational load, sponsored research funding, innovation activities, professional services. The Elsevier PURE Research Information Management System was integrated to support faculty with pre-filled profiles, containing data on results.

Faculty career ladder

Skoltech is committed to create supportive environment which rewards excellence and contribution of the personnel to research, teaching and innovation capacities. The Appointment, Promotion and Tenure Committee approved the following promotions:

- Professor Georgii Bazykin was promoted to Full Professor,
- Professor Anh-Huy Phan was promoted to Associate Professor,
- Professor Dmitry Dylov was promoted to Associate Professor,
- Professor Anatoly Dymarsky was promoted to Associate Professor,
- Professor Dmitry Titov was promoted to Associate Professor.
 Dr. Konstantin Tikhonov, Dr. Yuri Gladysh, Dr. Maria Logacheva,

Dr. Dmitry Yudin, Dr. Alexey Zaytsev received Assistant Professor appointments, having demonstrated outstanding results.

Contract renewals and terminations

Nine faculty contracts were extended: Professor Artem Abakumov, Professor Alexander Braverman, Professor Dmitrii Chudakov, Professor Andrzej Cichocki, Professor Maxim Fedorov, Professor Alexander Korsunsky, Professor Petr Sergiev, Professor Vladimir Spokoiny, Professor Denis Zorin.

Professor Pavel Troshin, Professor Marwan Charara, Professor Boris Fine, Professor Konstantin Piatkov, Professor Eric Achtmann left Skoltech due to contracts expiry or other reasons.

Personnel onboarding, learning and development

The onboarding and orientation program, designed by the HR team to create a friendly and comfortable immersion of newcomers, was conducted fully online. More than 40 participants learnt about Skoltech goals, core activities as well as received tips for efficient day-by-day activities.

Skoltech continued to invest in building organizational capabilities by offering a broad range of learning and development opportunities. Springer Nature online trainings for academic staff and students were arranged by the Provost Office. Jointly with the University of Iowa, the Education team organized workshops for faculty on "How to engage students in online teaching." A new pilot professional development course Facilitating and Assessing Learning was initiated by Professor Gustafsson (TU Chalmers) for course instructors and teaching assistants. The staff of research facilities participated in programs on safety requirements, attended site tours arranged by equipment producers and suppliers. The administration team attended trainings related to HR administration and recruitment, employer's brand, student admission, educational programs accreditation, financial management, GDPR data privacy professional, electronic document flow, project management. The omni management training allowed to learn and practice skills for managing teams in remote and hybrid formats.

The project PM.Science, aimed at creating sustainable supportive environment for project management, was launched as a joint initiative of HR and R&D Contract Office. In addition to regular meetings, the project management course was delivered to the first group of 20 managers. The "Training for Trainers" module will allow to train managers in-house based on unified standards. The Coursera for Skoltech project provided a free access to 3800 courses with a possibility to receive certificates. The major interest was raised for soft skills (leadership, emotional intelligence, presentation skills,

time management), as well as courses for Python and Excel.

Social responsibility activities

Skoltech continued engagement in social responsibility activities. In April, a volunteer project was launched for manufacturing protective face shields for users with a high risk of exposure to COVID-19. About 100 000 shields, produced by FabLab and assembled by staff, were delivered to Krasnodar, Krasnoyarsk, Vladikavkaz, Groznyi, Nizny Novgorod and Moscow hospitals, including Sklifosovsky Institute, MEDSI, Botkin hospital. The online Charity Christmas Tree, arranged with the Love Syndrome Fund, allowed to help children, teenagers and adults with Down syndrome. The donations went towards services that Syndrome of Love provides to families with Down syndrome members.



Student and alumni community

Student community

In 2020, the multicultural student community reached 1068 MSc and PhD students representing 47 countries. Around 30% are female students. The share of internationals reached 20%, mostly due to the target outreach to the regions of interest resulted in a higher rate of international enrollments.

Fostering student success

To educate the next generation of leaders in science, technology and business, Skoltech is building a holistic system for fostering student success, providing a variety of opportunities to develop professional, entrepreneurial and personal skills. Many students demonstrated achievements in academia, technology and startup tracks. The list below is far from exhaustive.

Academia track

Evgeny Kanin (PhD Petroleum Engineering) took the 1st place in Rosneft conference "Digital technologies in hydrocarbon recovery: from models to practice" (section Geomechanic modelling and hydraulic seam fracture).

Dmitri Travin (PhD Life Sciences), Sofia Medvedeva (PhD Life Sciences) received named fellowships of the Embassy of France in Russia (Ostrogradsky Fellowship, Mechnikov Fellowship).

Maksim Zakharkin (MSc Materials Science and Engineering) received the Ludo Frevel Crystallography Scholarship awarded to promising graduate students in crystallography-related fields.



Examples of excellence in publication output (first authorship or co-authorship in top international journals, A* conferences):

Aleksandr Artemenkov (MSc Data Science)

Artemenkov, A., & Panov, M.(2020) NCVis: Noise contrastive approach for scalable visualization. Paper presented at the The Web Conference 2020 - Proceedings of the World Wide Web Conference, WWW 2020, 2941-2947.

Arina Drobysheva (MSc Life Sciences)

Drobysheva, A., Panafidina, S., Kolesnik, M., Klimuk, E., Minakhin, L., Yakunina, M., Borukhov S., Nilsson, E., Holmfeldt, K., Yutin, N., Makarova, K., Koonin, E., Severinov, K., Leiman, P., Sokolova, M. (2021) Structure and function of virion RNA polymerase of a crAss-like phage. Nature, 589(7841), 306-309.

Anastasia Stolyarova (PhD Life Sciences)

Stolyarova, A., Nabieva, E., Ptushenko, V., Favorov, A., Popova, A., Neverov, A., & Bazykin, G. (2020) Senescence and entrenchment in evolution of amino acid sites. Nature Communications, 11(1)

Alexandra Galitsyna (PhD Life Sciences)

Ulianov, S., Zakharova, V., Galitsyna, A., Kos, P., Polovnikov, K., Flyamer, I., Mikhaleva, E., Khrameeva, E., Germini, D., Logacheva, M., Gavrilov, A., Gorsky, A., Nechaev, S., Gelfand, M., Vassetzky, Y., Chertovich, A., Shevelyov, Y., Razin, S. (2021) Order and stochasticity in the folding of individual drosophila genomes. Nature Communications, 12(1)

Marina Kalinina (PhD Life Sciences)

Kalinina, M., Skvortsov, D., Kalmykova, S., Ivanov, T., Dontsova, O., & Pervouchine, D. D. (2021) Multiple competing RNA structures dynamically control alternative splicing in the human ATE1 gene. Nucleic Acids Research, 49(1), 479-490.

Nikita Luchinin (PhD Materials Science and Engineering) Fedotov, S., Luchinin, N., Aksyonov, D., Morozov, A., Ryazantsev, S., Gaboardi, M., Plaisier, J., Stevenson, K., Abakumov, A., Antipov, E. (2020) Titanium-based potassium-ion battery positive electrode with extraordinarily high redox potential. Nature Communications, 11(1)

Dmitrii Semenok (PhD Materials Science and Engineering) Semenok, D., Kvashnin, A., Ivanova, A., Svitlyk, V., Fominski, V., Sadakov, A.,

HUMAN CAPITAL

Sobolevskiy, O., Pudalov, V., Troyan, I., Oganov, A. (2020) Superconductivity at 161 K in thorium hydride ThH10: Synthesis and properties. Materials Today, 33, 36-44.

Evgenii Anikin (PhD Physics)

Anikin, E., Chermoshentsev, D., Dyakov, S., & Gippius, N. (2020) Dyakonovlike waveguide modes in an interfacial strip waveguide. Physical Review B, 102(16)

Dmitry Chermoshentsev (PhD Physics)

Osminkina, L., Žukovskaja, O., Agafilushkina, S., Kaniukov, E., Stranik, O., Gonchar, K., Yakimchuk, D., Bundyukova, V., Chermoshentsev, D., Dyakov, S., Gippius, N., Weber, K., Popp, J., Cialla–May, D., Sivakov, V. (2020) Gold nanoflowers grown in a porous Si/SiO2 matrix: The fabrication process and plasmonic properties. Applied Surface Science, 507

Ilia Fradkin (PhD Physics) Fradkin, I., Dyakov, S., & Gippius, N. (2020) Nanoparticle lattices with bases: Fourier modal method and dipole approximation. Physical Review B, 102(4)

Technology track

Artyom Gadetsky (MSc Data Science), Vage Egiazarian (PhD Computational and Data Science and Engineering), Alexander Lyzhov (MSc Data Science), Denis Volkhonsky (PhD Computational and Data Science and Engineering) received Ilya Segalovich Award (Yandex) which remarks outstanding achievements in computer science.

Dejan Dzunja (MSc Data Science), through the internship at Bosch company secured a research contract for 10 months, which transferred to MSc Thesis. After graduation, Dejan was immediately hired by Bosch.

Artem Grebenko (PhD Physics), Natalia Katorova (PhD Materials Science and Engineering) and Filipp Obrezkov (PhD Materials Science and Engineering) received a prestigious award from Haldor Topsoe, a global leader in heterogeneous catalysis. Ilya Zakharkin (MSc Data Science), Arman Tsaturyan (MSc Data Science), Jonathan Tirado (MSc Space and Engineering Systems), Miguel Altamirano Cabrera (PhD Engineering Systems) with Zoom touch project and Miguel Altamirano Cabrera (PhD Engineering Systems), Igor Usachev (PhD Physics), Juan Heredia (MSc Space and Engineering Systems), Jonathan Tirado (MSc Space and Engineering Systems), Aleksey Fedoseev (MSc Space and Engineering Systems) with MaskBot along with 18 top international projects, presented their developments in ACM SIGGRAPH Asia 2020 Conference and Exhibition on Computer Graphics and Interactive Techniques.



We design educational 3D courses, which are available as video games to download into virtual reality glasses. We have two formats: a 3D computer game and a VR lab, offering school kids and students an opportunity to conduct experiments that are impossible to imagine in school or university settings. Moreover, virtual reality allows to safely explore new worlds, many of which are even hard to imagine. In addition, we have created a simple video test constructor, which we have already implemented in some schools in a test mode. It allows teachers to compose video tests themselves and to add interactive components to their lessons. Thus, a teacher immediately gets all the analytics about the lesson, its progress and results, helping to tailor the process to each student's needs on fly.

Khurram Pirov, PhD Computational and Data Science and Engineering, XREADY LAB co-founder



Startup track

Kirill Kurdin (PhD Materials Science and Engineering), Timur Ermatov (PhD Physics), Ilya Zakharkin (MSc Data Science) and Alisa Shaikhulova (MSc Materials Science) – became winners of UMNIK innovation scholarship.

Polina Morozova (PhD Materials Science and Engineering), Natalia Katorova (PhD Materials Science and Engineering) founded "K-Plus" startup (Sk resident) to create and market a new generation of batteries. The startup received the grant "Start" (2 mln Rub).

Evgeny Shilov (PhD Petroleum Engineering) co-founded Labadvance stratup (Sk resident), which focuses on optimization of enhanced oil recovery methods, evaluation of efficiency of different chemicals, numerical modelling of microfluids tests.

Khurram Pirov (PhD Computational and Data Science and Engineering) founded XREADY LAB startup, which designs 3D simulations for schools and universities.



We developed potassium ion batteries, cheap and reliable stationary power storage systems. We presented a working prototype as part of the Skoltech Translational Research and Innovation Program in December 2019. Our battery is twice as cheap as its lithium analog (per 1 kW • h of energy), but it is somewhat heavier. That is why our niche is stationary batteries for uninterruptible power systems, solar panels, and wind farms. In other words, systems where it is not necessary to frequently move the batteries but to store generated energy.

Polina Morozova, PhD Materials Science and Engineering, K-Plus co-founder





Evgeny Shilov, PhD student in Petroleum Engineering, Labadvance co-founder

Welcome to the class 2020

The recruitment campaign was influenced by the pandemic forcing the outreach team to move activities online and design new appealing formats. The admission plan was fully completed, leveraging a strong in-house marketing expertise. Being digital natives, talented and ambitions applicants responded with even higher interest to virtual open doors, lab tours, webinars, lectures, Q&A sessions, and Telearam channels. The pilot campaign to Germany, Italy, USA, Mexico, India, China, Nigeria, and Kazakhstan² was successful, bringing 1/3 of international enrollments.

In total, Skoltech received almost 18000 applications from 170 countries. The new cohort of 299 MSc and 136 PhD students joined Skoltech. 22% of enrollments are internationals from Argentina, Austria, China, France, India, Italy, Mexico, Nigeria, Romania, Serbia, Vietnam and other countries. 25% of the intake are double degree students under agreements with Higher School of Economics. **Moscow Institute of Physics** and Technology, Tomsk State University of Control Systems and Radioelectronics, Saint Petersburg State University of Aerospace Instrumentation.

Recruitment funnel	2019	2020
Applications	13881	17987
Invited to pre-selection	4346	7644
Invited to selection	941	888
Yield	416	435
% of enrolled	3%	2%

To assess the attractiveness of Skoltech offer, the Student Department and marketing team conducted a survey of the newcomers. Cutting-edge curriculum, international environment, intense research focus, and competitive benefits were named among the top reasons to choose Skoltech, top faculty and excellent research facilities.

> ² Regions of Skoltech interest, approved by the Academic Council.



Source: multiple choice survey on factors to choose Skoltech

The class 2020 was warmly	Founda
welcomed by faculty, administration,	Day, he
representatives of the Skolkovo	show.

Foundation during the Orientation Day, held as an 8 hours livestream show.



Student admissions at Skoltech have proven to be resilient to any external change: we have managed to carrying out all the supporting processes remotely, and with great efficiency. We owe the success of online admissions to the following tools: the Pruffme webinar platform, which we used for general applicant greetings and orientations; Zoom, where we held applicant interviews via several concurrent video chats; the Telegram messenger, which we used for E&I Challenge and general consultations; and the StartExam platform, which we deployed during the written exam in Advanced Level Mathematics, with integrated proctoring by the company ProctorEdu, which is cofounded our alumnus. Nevertheless, even with all the benefits offered by long-distance admissions, we once again discovered that offline face-to-face interaction with prospective students is a major advantage of traditional admissions. One can't overestimate its value.

Natalia Galochkina, Head of student admission, Student Department


Enhancing student experiences

Skoltech is committed to enhancing student experiences through career advising, nurturing student life and efficient support services. Opened in June, the Career Office rapidly ramped-up a number of programs. The Career Online Guide was designed to brief on the job market with "first hand" insights shared by employers. Online events with Sber, Huawei, X5 Retail Group, Raiffeisenbank, Yandex, Accenture, BostoneGene were organized. To extend the pool of partners, the Employers Guide was released to promote Skoltech top level araduates. **Regular communication with students** was enriched with monthly digests and individual sessions.

Student life provided opportunities to join sports clubs, social and volunteer projects, attend networking events. In addition to traditional Talent Show and International night, new formats were designed: Science Opera, Halloween party, online language exchanges with international universities. More than 20 sports clubs (football, volleyball, rock climbing, hockey, basketball, lawn tennis, badminton, cycling and others) and interest based clubs for startups development, movies, music and dances, glued the community of Skoltechians. Students were supported with services on issuing Moscow social cards, migration reaistration, medical insurance, access to sports facilities. A service for processing requests to attend online conferences was successfully piloted to save time in paperwork processing.

Student self-governance

The Student Council represents a voice of Skoltech multicultural student community. The Council's role is to support students on issues related to experiences at Skoltech, as well as deliver key messages to the administration. The Council composition is balanced with representatives of MSc and PhD students, international students.



Affected by the pandemic, we started the year remotely by operating under the new structure and regulations. This year, our focus was more on the problems faced by new students and the student body in general along with few online events. In coordination with, and help from, the student department, education office and administration we managed to solve (or initiated the solution for) range of problems. Be it Covidrelated problems, course quality, bicycle parking at campus, online clubs activity or any other initiative – our aim is to ensure that each and every student gets the best experience during their stay at Skoltech.

Salman Ali Thepdawala, the Student Council's President, Skoltech

Student Council composition

Salman Ali Thepdawala President

Vladislav Alekseev Miguel Altamirano Galina Burdukovskaia Anastasija Cumika Ayush Gupta Anton Hinneck Nina Konovalova Kirill Kurdin Nadezhda Matveeva Liliya Mironova Tuan Nguyen Marina Pak Polina Pilyugina Khattiya Pongsirijinda Anastasiia Rogozheva Lidiia Silkina Natalia Timusheva Zainab Waris Yakov Yermakov



The Student Council addressed COVID restrictions, quality of online courses, stipend issue, recognition of Skoltech PhD degree, networking events. The Council also released the student Handbook which briefs on the educational process, student life, campus facilities.

Future leaders in science, technology and business

For the first time in Skoltech history, the commencement ceremony was held online. More than 2000 viewers – faculty, graduates and their families, stakeholders, partners from MIT, TU Munich, University of Texas, ETH Zurich, HSE gathered to recognize achievements of graduation class 2020 and wish success in future career. The majority of graduates were employed during four months after graduation. 32% joined high-tech companies in Russia or established startups. Among the top employers are Huawei, Sber, Samsung, Yandex, Tinkoff. Mostly common positions are data scientist, software engineer, researcher, developer, analyst. Another 32% are in Skoltech, continuing for PhD or postdoc positions. 10% of graduates are in national universities (studying for PhD) or working in research centers. Those decided to continue for PhD or research abroad (14%) are in University of Alberta, Stanford, Oxford, Cambridge, EPFL, Caltech, Technical University of Denmark, Humboldt University of Berlin,

Uppsala University, European Molecular Biology Laboratory. 6% are employed abroad (Facebook UK, Redstone Digital GmbH, Chanwanich Company Limited, National Laboratory Astana, and others). 6% are involved in teaching (tutors or lecturers), work in governmental bodies in Russia, while 2% decided to take a gap year, considering uncertainty of the job market.

Building a worldwide alumni community

In 2020, Skoltech reached the milestone of 1000 alumni (graduation classes 2015 -2020). Around 76% of alumni are based in Russia, while others are spread in 37 countries of the world. The "technology track" alumni are working in top national and international companies (Sber, Huawei, Samsung, Tinkoff, Facebook etc.). Those decided to focus on academia, hold postdocs positions in Skoltech, research institutions in Russia, Germany, France and other countries. Some MSc graduates decided to continue for PhD at Skoltech or top universities abroad (EPFL, TU Munich, KU Leuven, Caltech, Oxford and others). The communication lines are kept open. Several programs were designed to involve alumni in outreach and fostering student success activities: True story, Ambassador Program, Career Digest and Career Online Hub.

CEREMONY

It was the freedom in choosing career development path that drew me to Skoltech

Nikita Chernyadev

CTO of Native Robotics (MSc in Space and Engineering Systems) After I graduated from Bauman University in 2018, I was uncertain about what university to choose for my MSc studies until I came to Skoltech Open Doors Day.

When applying for Skoltech, I knew for sure that I wanted to study robotics, although I was still hesitating between building career in academia or business. It was the freedom in choosing my career development path for the next two years that drew me to Skoltech: I could do research, write papers, join academic mobility or start my own business, expand network, and advance my entrepreneurial skills.

Strongly motivated by Innovation Workshop (which, luckily, was offline) and a freedom in designing the educational path, I decided during my first year to try my hand at entrepreneurship. My most important learning outcome is that I have founded Native Robotics jointly with Skoltech graduate whom I met at the Intelligent Space Robotics Laboratory of Skoltech Space Center. Starting from admission and the first days of Innovation Workshop, Skoltech encourages proactive thinking and offers a variety of opportunities for student development. What helps most in creating and driving your business forward is the proactive attitude inherent in Skoltech culture, as well as hard skills you acquire and polish during your studies.

Skoltech gave me opportunities to attend unique field-specific courses and workshops

Maria Matushko

(PhD in Mathematical Physics) What I found especially appealing about Skoltech was its stellar faculty of world-renowned mathematical physicists. Since I joined the first class of PhD students at the Center for Advanced Studies, there was no one around to share learning experiences. Still, the new program looked very promising thanks to the Center's founders and staff committed to improving quality of mathematical education. And my expectations were fully met: we attended exciting scientific events, including guest lectures by the world's top scholars, met with top quality students, researchers, and faculty joining Skoltech.

Along with unique field-specific courses and workshops, we attended conferences and schools that offered a highly stimulating environment for tackling new challenging tasks from scratch.

In 2020, I defended my PhD thesis "Limits of integrable systems of Calogero-Sutherland type". Right now, I am doing research in mathematical physics which in many ways is built on the results published during my studies at Skoltech. I am grateful for valuable experience I gained here as a teacher and speaker at various conferences and workshops.

Skoltech has top-notch faculty, inspiring environment, and fantastic research opportunities. I wanted to be part of it and learn a lot

Andrii Liashyk

research scientist at Skoltech Center for Advanced Studies (PhD in Mathematical Physics) I was among the first students to enter PhD program in Mathematical Physics at Skoltech Center for Advanced Studies. After earning MSc degree from Skoltech, I decided to continue here my PhD studies, since I believe that Skoltech with its top-notch faculty, inspiring environment and fantastic research opportunities has a lot more to offer in Mathematical Physics than any other Russian university. I wanted to be part of Skoltech and learn a lot. As an MSc student, I focused on research in Mathematical Physics, gaining fundamental knowledge that shaped my understanding of science. In 2020, I defended my thesis "Bethe vectors and their scalar products in quantum integrable models". In my PhD research, I focused on eigenvectors and their scalar products in quantum integrable systems with superalgebra symmetry. I continue to pursue this area of research, and by now I have defined a generalized field of application for classical results. At Skoltech, I made a lot of friends, gained valuable experiences and greatly expanded my scientific horizons.

Computer science research is highly important, as it helps create new solutions for driving the industry forward

Valentin Khrulkov

researcher at Yandex Research (PhD in Computational and Data Science and Engineering) As a schoolboy, I took interest in mathematics and computer science. After finishing Moscow school No 57, I earned MSc degree from Moscow State University Department of Mechanics and Mathematics and did PhD studies at Cornell University (USA) for two years before transferring to Skoltech PhD program Computational and Data Science and Engineering.

At Skoltech I was involved in applied research, designed and conducted numerical experiments. I also published over seven papers in data analysis and won the Ilya Segalovich award allowed me to have an internship in Yandex. I helped the Computer Vision group to develop a simpler way of assessing quality of photo resolution enhancement model. To do this, I compiled a dataset from all experimental data we had and trained the model to predict human response to image quality. I wrote a paper to make these findings available to other developers, which was accepted to the conference on computer vision.

I believe that computer science research is highly important, it helps to create new solutions for driving the industry forward.



Excellence making impact

World level research

Organization of agenda: target domains and Centers

Skoltech agenda for driving research, education and innovation is built in six target domains which address critical scientific, technological, and innovation challenges and gaps facing Russia and the world: Data Science and Artificial Intelligence Life Sciences and Health Cutting-edge Engineering Advanced Materials Energy Efficiency Photonics and Quantum Technologies Advanced Studies

Centers for Research, Education and Innovation (CREIs) are main contributors to Skoltech mission. They contuct cutting-edge basic & applied research and translational research to create marketing knowledge and allow technologies to mature, generate IP and create ecosystem which stimulates innovation culture and promotes startups establishment. Centers train next generation of leaders in science, technology and business by designing and delivering educational programs. Also, Centers provide advisory services on a variety of aspects of science and technology development to the national institutes of development (change agents), governmental bodies, high-tech companies. Skoltech standing and brand are promoted via prestigious conferences, schools, programs for the wider community, all developed and implemented by Centers academic personnel.

As of 2020, Skoltech has nine CREIs, two Centers in Wireless Technologies and Internet of Things, and Wireless Communication Technologies (within the CDISE) established under the National Technology Initiative, and the Digital Agro Laboratory. The framework of the target domains and Centers is sufficiently flexible to respond to the needs and challenges of the dynamic environment. The target domains are wide and serve as a long term, while the areas of Centers' specializations are reviewed on a regular basis to reflect emerging topics. No rigid boundaries exist between the domains, so the vast majority of the Centers operate in several domains.



Even though the pandemic had a huge impact on our academic and personal lives by changing the way Skoltechians work, commute, (non) travel, and conduct research there were many positive outcomes in our academic prominence. In 2020, we have published >1100 papers, doubled our share in Nature index journals, won >90 national and foreign grants, developed new innovative enterprises, graduated exceptional MS and PhD students of high distinction; and recruited yet another outstanding crop of students. By all measures we were able to adapt, recalibrate and rebalance to become even more productive in 2020 than could have been envisaged.

Keith Stevenson, Provost

Target Domains

			Data Science	Life	
			& Artificial	Sciences	
			Intelligence	& Health	
CDISE	Artificial Intelligence Mathematical Modelling	Transmission		an D a	
	& Computational	Digital Biomedicine			
Professor Nikolai Brilliantov	Technologies Information Processing &	Chemical Informatics & Digital Pharma			
	Bioinformatics	Drug design		RA	
Professor Mikhail Gelfand	Systems Biology Evolutionary Biology	Biomed Agro-Science			
CNRR	Developmental	Computational		K A	
Professor Mikhail Gelfand	Neurobiology Molecular Neurobiology	Neurobiology Analysis of medical date	. 🖄		
СРММ	Polymer-based composite	Metamaterials and			
	Materials Additive Manufacturing	Integrated Microwave Photonics			
	Technologies	Digital Design &	× *		
Professor Iskander Akhatov	Thermal Spray & Functional Coatings	Manufacturing Micro-Nano-Mechanics	3		
SC	Strategic Thinking & Digital	Space-Enabled Services			
Professor Anton Ivanov	Advanced Engineering				
СНР	Geomechanics Enhanced Oil Percovery	Gas Hydrates & Permafr Advanced Peservoir	rost		
CIIK	Geophysics & Petro-	Simulations			
Professor Mikhail Spasennykh	Physics of Unconventional Reservoirs	Data Science in Oil & Go Industry	as 🗢		
CECT	Electrochemical	& Storage			
CESI	Energy Storage Electrochemical Energy	Smart Energy Grids	ation		
Professor Artem	Conversion	Computational Energy			
Abakumov	Solar Energy Conversion	Materials			
CPQM	Photonic integrated	Polariton Bose-Einstein condensates			
	technologies	Quantum algorithms			
	Photonic ICT incl. THz and	Quantum communicatio	ns		
Professor Franko	Nanomaterials	and superconducting			
Kueppers	Biophotonics	technologies			
CAS	Geometric representation	Theory Symplectic geometry			
	String theory	Topology			
	Conformal and gauge	Statistical Physics			
	Integrable models	Dynamical systems Hyperb <u>olic geometry</u>			
Professor Igor Krichever	Combinatorics & Singularity				

Cutting-edge Engineering, Advanced Materials	Energy Efficiency	Photonics & Quantum Technologies	Advanced Studies

Research Highlights



The chromatin (DNA plus structural proteins) folding was studied in individual cells of Drosophila

Specially designed computational methods demonstrated stability of the folding, not expected a priori, and, in particular, the existence of compact structures, so-called **Topologically Associating** Domains, and their stable links to the functional (epigenetic) state of the chromatin. This distinguishes Drosophila cells from mammal cells studied earlier. as in the latter TADs appear only as a result of averaging over a large number of cells. Hence, the principles of chromatin folding in Drosophila and mammals are substantially different.

Skoltech scientific team is also interested in how changes in chromatin organization might be associated with disease, organism development and aging: "Assuming that chromatin architecture is tightly linked to gene expression, answering these questions might unravel the regulatory prerequisites of human development, aging, and disease."

Published in Nature Communications



A notion of meanders which can be traced back to H. Poincaré and naturally appears in various areas of mathematics, theoretical

physics and computational biology (in particular, as a model of polymer folding) is a topological configuration of a line and a simple closed curve intersecting transversally in the plane

Enumeration of meanders is an important open problem. The number of meanders with 2N crossings grows exponentially when N grows, but the long-standing problem on the precise asymptotics is still out of reach. It was show that the situation becomes more tractable if the topological type (or the total number of minimal arcs) of a meander is fixed. Then simple asymptotic formulas for the numbers of meanders as N tends to infinity were derived. The new tools which were brought to bear are based on interpretation of meanders as square-tiled surfaces with one horizontal and one vertical cylinder. The proofs combine recent results on Masur–Veech volumes of moduli spaces of meromorphic quadratic differentials in genus zero with our new observation that horizontal and vertical separatrix diagrams of integer quadratic differentials are asymptotically uncorrelated.

Published in Forum of Mathematics, Pi



In the area of AI a new algorithm for highquality online forecasts

for sequential data was developed

It is essential for various applications, including demand prediction, electricity consumption forecasting, weather forecasting, anomaly detection for predictive maintenance, etc. However, existing algorithms for

ensemble construction are either not suited for lona-term forecasts. because they operate only with 1-step-ahead predictions, or they are not adaptive, i.e., cannot track the changes in the individual experts' performance. The proposed algorithm is both adaptive and applicable to the online construction for longterm forecasting. Theoretical performance of the algorithm was proved as well as that the existing classical approaches are its specific cases. **Published in ScienceDirect**



In the investigation of potassium-ion batteries the concept of K-ion batteries has been developed

Tentative compositions for the cathode material were selected by computational screening of the

crystallographic database, and the most prospective candidates in terms of specific capacity and diffusion barriers were synthesized and electrochemically tested. The most prospective materials were found among those possessing the KTiOPO4-type structure, which appears to be a universal host capable of reversible (de)intercalation of four alkali cations (Li - Rb). Diffusion coefficients for all these cations were measured, and, surprisingly, potassium demonstrated highest diffusivity. Strong inductive effect in KTiPO4F allowed tuning the Ti3+/Ti4+ redox potential towards the value suitable for cathode application that is the highest value achieved up to date. A number of organic polymers capable of superfast charging either via pseudocapacitive mechanism or via dual-ion mechanism were synthesized and electrochemically tested. Hard carbon anodes for K-ion batteries were developed (patented), mechanism of K insertion and SEI formation was investigated with transmission electron microscopy. Chemical prepotassiation procedure (patent pending) was proposed in order to enable assembling full K-ion cells. Prototypes of the K-ion pouch cells were constructed based on hexacyanoferrate cathode, hard carbon anode and concentrated diglyme electrolyte (patented).

Published in Nature Communications (The article was mentioned in the Nature Communications Editors' Highlights webpage on energy materials).



A new method of multispectral sensing of biological liquids with hollow-core microstructured optical fibres was proposed

The state of the art in optical biosensing is focused on reaching high sensitivity at a single wavelength by using any type of optical resonance. This common strategy, however, disregards the promising possibility of simultaneous measurements of a bioanalyte's refractive index over a broadband spectral domain. Now this issue was addressed by introducing the approach of in-fibre multispectral optical sensing (IMOS). The operating principle relies on detecting changes in the transmission of a hollowcore microstructured optical fibre when a bioanalyte is streamed through it via liquid cells. IMOS offers a unique opportunity to measure the refractive index at 42 wavelengths, with a sensitivity up to 3000 nm per refractive index unit (RIU). This technique was applied to determine the concentration and refractive index dispersion.

Published in Light: Science & Applications

High impact publication output

As reported (refer to "Common data set"), the total number of Skoltech publications in 2020 reached 1131. Ensuring a growth of the output compared to 2019, Skoltech maintained the highest level publishing 63% papers in Q1 journals, and 13% in the most prestigious Nature Index journals as indexed in Scopus. With regards to the standing in Artificial Intelligence (A* conferences), Skoltech holds a leading position among national universities, research institutions and companies. The total number of papers in A* conferences during 2018 – 2020 reached 45.

Select examples are highlighted below:

Center for Computational and Data-Intensive Science and Engineering

Kozlovskii, I., & **Popov**, **P.** (2020) Spatiotemporal identification of druggable binding sites using deep learning. Communications Biology, 3(1)

Center of Life Sciences

Sharonov, G., Serebrovskaya, E., Yuzhakova, D., Britanova, O., **Chudakov**, **D.** (2020) B cells, plasma cells and antibody repertoires in the tumour microenvironment. Nature Reviews Immunology, 20(5) 294-307

Osterman, I., Wieland, M., Maviza, T., Lashkevich, K., Lukianov, D., Komarova, E., Zakalyukina, Y., Buschauer, R., Shiriaev, D., Leyn, S., Zlamal, J., Biryukov, M., Skvortsov, D., Tashlitsky, V., Polshakov, V., Cheng, J., Polikanov, Y., Bogdanov, A., Osterman, A., Dmitriev, S., Beckmann, R., Dontsova, O., Wilson, D., Sergiev, P. (2020) Tetracenomycin X inhibits translation by binding within the ribosomal exit tunnel. Nature Chemical Biology

V.Zelman Center for Neurobiology and Brain Restoration

Khrameeva, E., Kurochkin, I., Han, D., Guijarro, P., Kanton, S., Santel, M., Qian, Z., Rong, S., Mazin, P., Sabirov, M., Bulat, M., Efimova, O., Tkachev, A., Guo, S., Sherwood, C.C., Gray Camp, J., Pääbo, S., Treutlein, B., **Khaitovich**, **P**. (2020) Single-cell-resolution transcriptome map of human, chimpanzee, bonobo, and macaque brains.Genome Research, 30(5) 776-789

Center for Design, Manufacturing and Materials

Safonov, A., Gusev, M., Saratov, A., Konstantinov, A., Sergeichev, I., Konev, S., Gusev, S., Akhatov, I. (2020) Modeling of cracking during pultrusion of large-size profiles. Composite Structures, 235

Tikhomirova, K., Tantardini, C., Sukhanova, E., Popov, Z., **Evlashin, S.**, Tarkhov, M., Zhdanov, V., Dudin, A., Oganov, A., **Kvashnin, A.** (2020) Exotic two-dimensional structure: The first case of hexagonal NaCl. Journal of Physical Chemistry Letters, 11(10), 3821-3827.

Evlashin S., Fedorov F., Dyakonov P., Maksimov Y., Pilevsky A., Maslakov K., Kuzminova Y., Mankelevich Y., Voronina E., Dagesyan S., Pletneva, V., Pavlov, A., Tarkhov, M., Trofimov, I., Zhdanov, V., Suetin, N., **Akhatov**, I. (2020) Role of Nitrogen and Oxygen in Capacitance Formation of Carbon Nanowalls. Journal of Physical Chemistry Letters, 11(12) 4859-4865

Space Center

Rodríguez Gómez, J.M., **Podladchikova, T.**, Veronig, A., Ruzmaikin, A., Feynman, J., Petrukovich, A. Clustering of Fast Coronal Mass Ejections during Solar Cycles 23 and 24 and the Implications for CME-CME Interactions (2020) Astrophysical Journal, 899 (1), art. no. 47.

Toche, B., Pellerin, R., & Fortin, C. (2020) Set-based design: A review and new directions. Design Science, Vol 6

Center for Hydrocarbon Recovery

Chekhonin, E., Popov, Y., Peshkov, G., Spasennykh, M., Popov, E., Romushkevich, R. (2020) On the importance of rock thermal conductivity and heat flow density in basin and petroleum system modelling. Basin Research, 32(5) 1271-1286

Popov, E., Popov, Y., Chekhonin, E., Safonov, S., Savelev, E., Gurbatova, I., **Ursegov, S.**, Shakirov, A. (2020) Thermal core profiling as a novel and accurate method for efficient characterization of oil reservoirs. Journal of Petroleum Science and Engineering, 193

Kanin, E., Garagash, D., Osiptsov, A. (2020) The near-tip region of a hydraulic fracture with pressure-dependent leak-off and leak-in. Journal of Fluid Mechanics,

892 Markovic, S., Bryan, J., Turakhanov, A., **Cheremisin**, **A.**, Mehta, S., Kantzas, A. (2020) In-situ heavy oil viscosity prediction at high temperatures using low-field NMR relaxometry and nonlinear least squares. Fuel, 260

Eskin, **D.**, Meretskaya, E., Vikhansky, A. (2020) A model of breakup of a rising bubble in a turbulent flow. Chemical Engineering Science, 226

Temirchev, P., Simonov, M., Kostoev, R., Burnaev, E., Oseledets, I., Akhmetov, A., Margarit, A., Sitnikov, A., Koroteev, D. (2020) Deep neural networks predicting oil movement in a development unit. Journal of Petroleum Science and Engineering, 184

Chuvilin, E., Sokolova, N., Davletshina, D., Bukhanov, B., Stanilovskaya, J., Badetz, C., Spasennykh, M. (2020) Conceptual models of gas accumulation in the Shallow permafrost of northern west Siberia and conditions for explosive gas emissions. Geosciences (Switzerland),10(5)

Center for Energy Science and Technology

Akbulatov, A., Frolova, L., Dremova, N., Zhidkov, I., Martynenko, V., Tsarev, S., Luchkin, S., Kurmaev, E., Aldoshin, S., Stevenson, K., Troshin, P. (2020) Light or heat: What is killing lead halide perovskites under solar cell operation conditions? Journal of Physical Chemistry Letters, 11(1), 333-339.

Fedotov, S., Luchinin, N., Aksyonov, D., Morozov, A., Ryazantsev, S., Gaboardi, M., Plaisier, J.R., Stevenson, K., Abakumov, A., Antipov, E.V. (2020) Titanium-based potassium-ion battery positive electrode with extraordinarily high redox potential. Nature Communications, 11(1)

Center for Photonics and Quantum Materials

Ermatov, T., Noskov, R., Machnev, A., Gnusov, I., Atkin, V., Lazareva, E., German, S., Kosolobov, S., Zatsepin, T., Sergeeva, O., Skibina, J., Ginzburg, P., Tuchin, V., Lagoudakis, P., Gorin, D. (2020) Multispectral sensing of biological liquids with hollow-core microstructured optical fibres. Light: Science and Applications, 9 (1)

Center for Advanced Studies

Aggarwal, A., Delecroix, V., Goujard, É., Zograf, P., & **Zorich**, A. (2020) Conjectural large genus asymptotics of Masur–Veech volumes and of area Siegel–Veech constants of strata of quadratic differentials. Arnold Mathematical Journal, 6(2), 149-161.

Increase of grant funding

In 2020, Skoltech increased sponsored research funding and was awarded 1 bln Rub under new 93 national and foreign grants. The research projects will span a wide range of subjects, including medical data analysis, deep neural networks, novel computer vision methods, machine learning, CRISPR-Cas, new generation of Li-ion batteries, nonlinear optical effects, quantum informatics and quantum optics, modern mathematical physics, etc. The European funding (HORIZON) was awarded to the project for developing a hybrid energy storage system. Among the visible national awards are grants for setting world class labs in power systems, machine learning, sustainable development of liquid hydrocarbon reserves.

Grant project	PI	Award, mln Rub	Period	Funding agency
World-level science center "Sustainable development of global hydrocarbon reserves"	Professor Mikhail Spasennykh, Skoltech	593	2020 – 2025	Ministry of Science and Higher Education
Advanced Monitoring, Protection and Control of Future Power Systems	Professor Vladimir Terzija, University of Manchester and Skoltech	90	2021 – 2023	Ministry of Science and Higher Education
Multiscale intelligent neurodynamic systems for multidimensional optimization with machine learning and data processing applications	Professor Wang Jun, The Chinese University of Hong Kong and Skoltech	90	2021 – 2023	Ministry of Science and Higher Education
Development of a sustainable hybrid storage system based on high power vanadium redox flow battery and supercapacitor – technology	Professor Ibanez Federico Martin, Skoltech	31	2020 – 2023	European Commission

Skoltech scientists were successful in receiving funding for COVID related projects (Russian Foundation for Basic Research):

- Professor Georgii Bazykin (Project:"Fundamental aspects of molecular epidemiology of SARS-CoV-2"),
- Professor Konstantin Lukyanov (Project:"Genetically encoded fluorescent probes for studying the dynamics of intracellular transport and interaction of SARS-CoV-2 proteins and creating safe cellular screening platforms"),
- Dr. Marat Kazanov (Project:"Bioinformatics prediction and comparative genomic analysis of coronavirus proteolytic cleavage sites"),
- Dr. Alexey Yashchenok (Project: A new approach for the treatment of viral respiratory tract infections, including SARS-CoV-2, based on targeted binding of vaterite particles containing encapsulated ribonuclease").

The PhD research projects were supported with 26 grants of Russian Foundation for Basic Research awarded to students from Center of Life Sciences, V.Zelman Center for Neurobiology and Brain Restoration, Center for Computational and Data-Intensive Science and Engineering, Center for Energy Science and Technology, Center for Photonics and Quantum Materials.

Research and innovation partnership with MIT

Skoltech – MIT Next Generation Program (NGP) was continued with two Calls for joint faculty projects. Based on the results of peer-review process, the Steering Committee, composed of Skoltech and MIT senior faculty, reviewed and made recommendations on the following proposals for awarding funding:



The dangers of COVID-19 were apparent immediately. We focused on it as early as in January, designing epidemiology models and consulting government agencies. Starting from March, we studied the genomics of SARS-CoV-2 in Russia. We traced details of its introduction and spread, and deciphered the causes of individual outbreaks. More globally, we use genomics to study the interaction between the virus and the host immune system. Our results are actionable, and inform health care decisions.

Georgii Bazykin, Full Professor, Center of Life Sciences

Skoltech co-project leader	MIT co-project leader	Project
Profesor Artem Abakumov	Jennifer L.M. Rupp, Department of Materials Science and Engineering	Atomic-level Understanding of Interface Structure Evolution for Next Li Solid State Batteries
Professor Dmitry Dylov	Jacob White, Department of Electrical Engineering & Computer Science	Learning-Paradigm Based Acquisition Techniques for Hand-Held Magnetic Resonance Imagers.
Dr. Alexandra Boldyreva	Rafael Jaramillo , Department of Materials Science and Engineering	New chalcogenide and chalcohalide semiconductors for environmental sensing and renewable energy
Professor Keith Stevenson	Fikile Brushett, Assoc. Professor Chemical Engineering	Energy-dense and Durable Nonaqueous Redox Flow Batteries enabled by Flowing Solid-state Capacity Boosters
Professor David Pozo	Munther Dahleh, Department of Electrical Engineering and Computer Science	Market Design for Electromobility: New Formulations, Models and Algorithms
Professor Maria Sokolova	Michael T. Laub, Department of Biology	Elucidating the molecular foundations of an ancient arms race between two major classes of bacteriophages and their hosts
Professor Sergey Abaimov	Brian L Wardl e, Department of Aeronautics and Astronautics	Multifunctional Fusion: Life- cycle enhancements via data- driven nanoengineering of advanced composite structures
Evgeny Burnaev	Justin Solomon, Associate professor Electrical Engineering & Computer Science	Unpaired learning from irregular geometric modalities
Professor Zeljko Tekic	Douglas Hart , Department of Mechanical Engineering	The Skoltech1Million Entrepreneurial Challenge

The Call for innovation proposals was opened to MIT project leaders representing any school, department, laboratory, or a center. Ten projects in immunotherapy, energy conversion, robotics, climate change in Russian Arctic received funding awards.

Research facilities

The shared facilities completed services for more than 70 external clients (total 22 mln Rub), as well as internal clients (total 24 mln Rub). The majority of services for external clients were provided by FabLab, Advanced Imaging and Genomics Core Facility. The certification audit was successfully completed with receiving QMS certificates for compliance with ISO 9001. Currently, the documents are being prepared for obtaining accreditation of the Advanced Imaging Facility in accordance with ISO 17025 and a license from Roscosmos. Within the grant of Moscow, the Skolkovo Foundation purchased for Skoltech research equipment for 200 mln. Rub to be installed at FabLab, Advanced Imaging and Laboratory of Nanomaterials (Center for Photonics and Quantum Materials).







Educating leaders

Response to the pandemic

The decision to transfer face-to-face teaching and learning to the online mode due to COVID-19 was not only an exceptional challenge for all Skoltech, but fundamentally affected the educational processes. Leveraging a strong foundation of online systems and tools, along with highly qualified faculty and staff, the educational process was smoothly transferred online, allowing to deliver 10 MSc and 7 doctoral programs for 1068 students. Accepting limitations of interpersonal communication, teamwork, experiential and applied learning, new opportunities were pursued, such as expansion of online resources and development of digital tools. Faculty worked hard to create virtual labs and come up with alternative lab scenarios.

MSc defenses

The pandemic severely impacted students' plans for theses preparation and delivery – the academic mobility was cancelled, research supervision performed remotely, a large proportion of experimental work was not finalized due to restricted access to research facilities. Although the pre-defenses and defenses were held online, Skoltech evidenced exceptional faculty engagement, higher quality of students' presentations, seamless and professional integrated work of the committees.

302 MSc students successfully defended thesis projects in front of the state attestation committees composed of mostly 100 faculty, academia and industry experts.

MSc Program	MSc Graduates
Advanced Manufacturing Technologies	19
Life Sciences	39
Information Science and Technology	25
Data Science	95
Energy Systems	14
Materials Science	21
Mathematical and Theoretical Physics	8
Petroleum Engineering	23
Photonics and Quantum Materials	24
Space and Engineering Systems	34
TOTAL	302

Canvas LMS (Learning Management System) is a modern platform, where all the main players, whether faculty, instructors or students, can easily come together to serve the primary mission of effective and engaged learning, which in this new online world, is more important than ever. Skoltech uses Canvas effectively, not only for courses but for MSc and PhD research, for the Industrial Workshop and the Industrial Immersion, and for the ISP courses and defenses. With Canvas, Skoltech is well prepared for online learning. Canvas works alongside other tools and formats like Zoom, YouTube, Telegram chats, etc. Not all modes of instruction translate easily to online platforms, but the best online tools have been integrated. However, the main concern of everybody was the effectiveness of the education process without faceto-face contact and outside of the lab.

Matthew Mulherin, Head of the Education Office

The highest appraisal received the following theses:

Student	Thesis Title	Research Advisor
Doston Shayunusov MSc Petroleum Engineering	Simulation of Gas Hydrate Deposition in Pipelines	Prof. Dmitry Eskin
Ekaterina Isachenko MSc Advanced Manufacturing Technologies	Aerodynamic and Aeroacoustic Modeling of a Contra-rotating UAV Propeller and Validation against the Experiment	Prof. Ighor Uzhinsky
Oluwaseun Oladimeji MSc Energy Systems	Electromobility: The Value of EV Fleets Coordination	Prof. David Pozo
Alexey Sanin MSc Materials Science	NASICON Superionic Conductors — Synthesis Optimization and Performance Conservation	Prof. Keith Stevenson
Vladislav Lukoshkin MSc Information Science and Technology	Generalized Finite Element Solver for Multiscale Problems	Prof. Ivan Oseledets
Bakhyt Zharkynbay MSc Data Science (Chairman Vadim Strijov)	Solving Optimal Stopping Problems via Approximate Dynamic Programming	Prof. Vladimir Spokoiny
Dmitriy Krylov MSc Data Science (Chairman Anton Konushin)	Reinforcement Learning for Suppression of Collective Activity in Oscillatory Ensembles	Prof. Dmitry Dylov
Elena Petrova MSc Space and Engineering Systems	Forecast of the F10.7 cm and F30 cm Radio Flux for Orbit Prediction Needs	Prof. Tatyana Podladchikova
Vasily Rogov MSc Mathematical Physics	Non-algebraic Deformation of Flat Kahler Manifolds	Prof. Aleksandro Skripchenko
Anton Khvalyuk MSc Theoretical Physics	Low Energy Excitations in Superconductors Close to Superconductor-Insulator Transition	Dr. Mikhail Feigelman
Daniil Rabinovich MSc Photonics and Quantum Materials	Magnetoelectric Effects in Superconducting Heterostructures	Prof. Mikhail Skvortsov
Arina Drobysheva MSc Life Sciences. Molecular Biology	Transcriptional strategy of the crAss- like Phage phi14:2	Prof. Maria Sokolova
Hilary Edema MSc Life Sciences. Bioinformatics	Comparative Genomic Analysis of Lignin Degradation and Its Transcriptional Regulation in Streptomyces spp.	Prof. Mikhail Gelfand

PhD defenses

Since 2017, 88 PhD graduates have successfully defended PhD thesis: 75

have been awarded with Skoltech Doctor of Philosophy degree, while 13 with Candidate of Science degrees at external committees.

The defenses were organized in a hybrid mode with online presence of jury external members, while keeping a requirement of on site attendance of 1/3 of the jury members. Among 63 PhD graduates, 33 successfully defended on time within the standard 4-year duration of the doctoral program: 26 defended Skoltech PhD degree and 7 defended at the external committees (Higher School of Economics, Moscow Institute of Physics and Technology, Landau Institute).

PhD Program	PhD graduates 2020	Skoltech defenses	External defenses
Computational Data Science and Engineering	14	6	1
Engineering Systems	13	4	-
Physics	9	4	3
Petroleum Engineering	8	3	-
Materials Science and Engineering	7	4	-
Life Sciences	7	4	-
Mathematics & Mechanics	5	1	3
TOTAL	63	26	7

Cotutelle programs

Having a strong international outlook, Skoltech supported joint doctoral programs with leading international universities through the customized cotutelle agreements. Among Skoltech partners are KU Leuven, RIKEN, Aalto University, Curtin University, Ben Gurion University, Sorbonne, ETS Montreal, University of Paris, University Grenoble Alps. The joint defenses were organized with Curtin University and Aalto University.

PhD student	Supervisors	Thesis title
Anastasia	Professor Alexey	Dynamic modelling and
Ivanova	Cheremisin (Skoltech)	experimental evaluation of
PhD Petroleum	Professor Ahmed Barifcani	nanoparticles application in
Engineering	(Curtin University)	surfactant enhanced oil recovery
Pramod	Professor Albert	Hybrid heterojunction solar
Mulbagal	Nasibulin (Skoltech)	cells using single-walled carbon
Rajanna	Professor Peter Lund	nanotubes and amorphous
PhD Physics	(Aalto University)	silicon thin films

Internationally recognized programs

International recognition of Skoltech programs is verified by external experts. In April 2020, international accreditation of PhD programs "Materials Science and Engineering" and "Computational and Data Science and Engineering" was successfully completed by the EUbased High Council for Evaluation of Research and Higher Education (HCERES). As mentioned in the evaluation reports, both programs satisfy evaluation criteria, internal quality assurance mechanisms are in place and effectively used to improve the doctorate continuously. Thus, in total Skoltech had three PhD programs accredited in EU

("Life Sciences" program received accreditation in 2019).

Enhancing the educational offer

New MSc programs were designed to open admission in 2021: "Internet of Things and Wireless Technologies" and "Advanced Computational Science". To close the gap caused by postponing the Innovation Workshop due to the pandemic, the Center for Entrepreneurship and Innovation delivered a few new courses:

 Hack Lab: Laboratory for Ideas (Professor Zeljko Tekic) allowed mostly 200 students to gain experience in innovation sprints and problem solving under resource and time constraints hack real-life problems jointly with top companies (Tinkoff, Lenta, AstraZeneca, NVIDIA, Sbermarket, and Accenture).

- Startup Funnel (Professor Dmitry Kulish, Professor Alexey Nikolaev) was launched as a learning-bydoing course to accelerate teams and give real-world hands-on experience of creating a startup.
- Internet of Things: Launching New Products & Startups (Professor Alexey Nikolaev) provided students with hands-on, immersive skills of translating IoT technology into new AI/IoT/digital products and then technology-based startups.

The course Teachers Toolkit for Higher Education jointly with Moscow Pedagogical State University was offered to students willing to broaden pedagogical skills.

The Independent Studies Period was a joint effort of faculty, students, and invited speakers. Among some examples of courses delivered are:

- Critical Dialogues on Arts and Science (Professor Shpanin, Rutgers University, and worldwide famous artists)
- Languages of the World: Understanding Them by Solving

Linguistic Problems (Dr. Boris Iomdin, V.V. Vinogradov Institute of Russian language, Russia)

- Financial Literacy and Personal Finance (Krasik Sofia, MSc Life Sciences)
- Roadmap to Career Success (among the speakers were Lada Simacheva (Head of the Career Center), Ivan Bogdanov (Head of Industrial Liaison Office), Lyudmila Primako (Antal Russia), Ekaterina Mikhailova (Changellenge), Ekaterina Tretyakova (Antal Russia), Vladimir Volkov (MTS),
- New Space Startup Bootcamp (Professor Alessandro Golkar)
- ProfiRu Hackathon by HackLab (Professor Zeljko Tekic)
- How to Stop Worrying about Art and Start Enjoying It (Professor Natalia Mazur, European University at Saint Petersburg) delivered by Skoltech partner under the New League of Universities.

The Industrial Immersion was a challenge due to the online format. Even with that, over 200 projects were co-supervised by faculty and industry representatives at more than 100 national and international companies, including Skolkovo startups. The results were presented to industry and business experts during the Industry Day.

Digital library

Being a core pillar of Skoltech learning experiences, in 2020 the library played a crucial role in successful switch to the online mode. Students had access to top international databases such as Science Direct, Springer or IEEE, bibliographic databases (Scopus, Web of Science, etc.), Springer e-books collection and Elsevier Freedom Collection.

2017	2018	2019	2020
700	930	1 100	1 248
220	370	420	435
-	-	4 900	6 000
70 000	85 000	71 000	50 400
50 000	110 000	240 000	210 000
	2017 700 220 - 70 000 50 000	2017 2018 700 930 220 370 - - 70 000 85 000 50 000 110 000	2017201820197009301 1002203704204 90070 00085 00071 00050 000110 000240 000


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Cultivating entrepreneurial readiness and spirit

Widening E&I curriculum

The Startup Funnel was designed by faculty of the CEI and Innovation as a chain of E&I courses to guide students from "idea" to an application to create a startup sustainable enough to join the Skolkovo ecosystem. Conducted fully online, the Funnel included Technology Entrepreneurship Foundations (for MSc students), Startup Founders Workshop (for PhD students), followed by the project-based Startup Workshop (for MSc and PhD students) and a specialized course for to prepare a Skolkovo residency application. Six projects submitted applications, including LASY (selfadjustment systems for commercial and scientific laboratories to maximize reproducibility), Spheroid Revolution (software to control spheroids quality and functional properties for 3D bioprinting application), Plasmaster

(plasma enhanced sterilizer for hands and surfaces), BeDance (software for assessing the accuracy and dynamics of movements in real time), Move. Now (wearable device for efficient and convenient knee rehabilitation), and UniApp (mobile platform that combines a navigation system in closed environment with additional integrated content). BeDance, Spheroid Revolution, Move.Now passed Sk expertise to become Skolkovo residents. Jointly with the Moscow School of Management, Skoltech hosted the Startup Academy, helping to develop business from scratch. Mostly 90 students worked on 29 projects, gaining knowledge from founders and entrepreneurs on project development. In general, more than 500 students participated in E&I courses, more than 50 student projects were developed and pitched to business and industry representatives.

Fostering entrepreneurial environment

The Translational Research and Innovation Program (STRIP) was redesigned to fill the gap between results and market expectations. The program Year 1 focuses on research and MVP development, while Year 2 is concentrated on pre-seed acceleration of the most promising projects. 10 industry applied projects were approved for funding in 2021 - 2022, including a smart sensor for food quality control based on carbon nanotubes and AI algorithms, a new combo treatment for hepatocellular carcinoma, the first portable massspectrometer for identification bacteria and virus SARS CoV-2, a universal management system for redox flow batteries. Within the NGP, the project "Skoltech1Million Entrepreneurial Challenge" will be developed

jointly with MIT to foster students' entrepreneurial skills.

Leveraging opportunities of the Skolkovo ecosystem

Five Skoltech projects joined Sk IGTech incubation program. Mentoring startups on investment issues was carried out with support of Skolkovo Ventures. Skoltech also took part in ecosystem events. 12 Skoltech associated startups were selected to semifinals of Startup Village 2020 - HeadKraken, Tetraquant, CyberPhysics, SmugNet, Native Robotics, WareVision, Ecobot, Labadvance, XREADY LAB, Move. Now, Laminate IT, and BazAR. Native Robotics and HeadKraken, reached the final. Native Robotics was the second in IT track, while HeadKraken was the fourth. Six startups participated at Startup Bazaar.



For many years CEI has been developing pedagogical and organization tools that would facilitate the ultimate goal of inspiring and equipping Skoltech students towards founding their own technology startups immediately after joining Skoltech. Such endeavour is not easy for students, because in parallel they have to satisfy the most stringent criteria of academic and research excellence. In 2020, this goal was accomplished through concerted execution of Skoltech Startup Funnel system, that united teaching by CEI faculty, mentoring by CEI Business Development, and organizational support by Skoltech administration. In July, the group of PhDs defined projects (based on their Skoltech studies) at the introductory E&I course "Startup Founder Workshop". In September, the nascent projects were brought by PhDs to the MSc introductory course "Innovation Workshop". The resulting teams developed their business plans during November "Startup Workshop" and three freshly minted projects passed Sk expertise to become Sk residents. CEI is very proud of this success and intends to replicate it many years ahead.

Dmitry Kulish, Professor of the Practice, Center for Entrepreneurship and Innovation

Technology to market

Skoltech was founded as a core element of the Skolkovo project to re-create a foundation for national high-tech industry, leveraging on the boost in research and entrepreneurship in science-intensive areas of economy. In this paradigm, Skoltech acts as a catalyst for developing promising areas by creating environment for world-class specialists, conducting cutting-edge research and building technology groundwork.

Today, being a core element of the national system of "change" agents or the innovation institutes of development, Skoltech initiates and conducts ambitious projects for developing economy and society, ensures applied research and technology transfer through prototypes and pulling technologies to the level of readiness as assessed by industry. By doing that, Skoltech serves as a think and act tank. facilitating technology transfer and scaling by high-tech companies, when technologies bring a sustainable economic and societal impact. In 2020 Skoltech signed 89 new contracts totalling 1.2 bln Rub. The overall portfolio is composed of large scale national technology projects (Digital technologies, National technology initiative), projects performed to aerospace, agricultural and biotechnology, oil and gas, telecommunications industry. Despite COVID challenges influenced on the R&D budgets, access to research facilities, all Skoltech contractual obligations were fulfilled.





4/5G software is unique in Russia, and OpenRAN support provides an opportunity for bringing our solution both to the local and global markets. State registration gives us every right to claim that our software is a Russian product, which is particularly important in the light of the government's instruction to build 5G networks using Russian hardware only. Our technology partners, Eltex and Radio Gigabit, are responsible for the hardware part of the project and, just like ourselves, are following the roadmap and have already built a 5G base station prototype. In 2021 we expect to start testing the base station prototypes jointly with operators. This will help identify and meet the market players' needs and lay the basis for future market demand for our solution.

Dmitry Lakontsev, Head of the Skoltech-based NTI CoE

Technology Highlights

Next generation of 5G communications

- The first version of the national software for the base station was developed, the station was tested in the network of MTS company (Project "Base station 4/5G with open architecture").
- Skoltech and MTS launched the first stage of the pilot zone, including the base station with software, developed by Skoltech (Project "Pilot 5G zone in Skolkovo Innovation Center").
- The prototype of the network was presented to top management of

Russian Railways company, including transmission of various types of traffic, protected by a quantum key distribution system (Project "Demonstration of the prototype of the wireless 5G network secured with a system of quantum key distribution systems").

• Skoltech won the competition for implementing the product at the Seversky Pipe Plant, the tasks and a plan of work have been approved (Project "DATASKAI industrial data processing framework").



AI in medicine

Sber and Skoltech signed an agreement on creating ecosystem for development of AI in healthcare in Russia. The ecosystem operator is the company SberMedAI, established last summer. Skoltech research expertize and Sber cloud-based engineering infrastructure will be combined in a powerful technological platform for healthcare services, providing developers with access to a unique collection of well-structured medical data and cutting-edge data processing algorithms and tools. The combined library of applications for data sets and assistance in making medical decisions, formed on the basis of developments of Sber and Skoltech CoBrain project, is currently one of the largest in Russia.

Sber and Skoltech's joint effort has resulted in one of Russia's largest libraries of applications and datasets for medical decision-making. Skoltech's NTI CoBrain Analytics project (2016-2020) is a major contributor to the database.

SberMedAI and Skoltech develop medical solutions using 50 AI models. Their new services are already available to over 40 million people in 16 Russian regions. As part of this effort, SberMedAI has launched a medical decision support system based on the SberBank Artificial Intelligence Laboratory's algorithms and providing a second opinion on the diagnosis. The new "Lung Computer Tomography" service that helps identify various lung diseases, including those caused by COVID-19, is being pilot-tested in Moscow, Tambov, and Orenburg region, Republic of Buryatia, Krasnodar region.

Al in industry

- Jointly with MTS Skoltech develops algorithms of active learning for processing tasks and methods for analyzing toxic comments.
- The project for development of the system for predictive diagnostics for gas turbine power plants was completed for "MGTES" (part of ROSSETI). The predictive system is needed for early detection of pre-failure conditions of

equipment and taking measures to eliminate the problem. The technologies of digital twins and machine learning were applied, physical and mathematical models for all main systems and units of MGTES engine were developed. The software for predictive analytics was developed and put into test operations. Further, the system will be adjusted for each installation.

Oil and gas

- Skoltech and Gazprom Neft completed the project to develop methods for metamodeling of multiphase reservoir flows. The library of algorithms, that accelerate classical methods of full-fledged 3D modeling of reservoir flows (200 times more) and allow to select more precisely the optimal scheme of developing the field, has been designed. The metamodel is undergoing industrial testing at Gazprom Neft fields.
- The technology has been developed for constructing a digital twin of a core for a lowpermeability reservoir of the Achimov Formation (Gazprom Neft).

New enterprises and technology licensing

Growing number of startups

The portfolio of Skoltech associated startups, founded by faculty, researchers, students, and alumni, reached 93. The vast majority of the companies are based in Russia. 57 startups (cumulative result for 2012 – 2020) obtained the Skolkovo residence status.

Among examples of companies became Skolkovo residents in 2020:

- SberMedAI (Sber, Skoltech) creates medical solutions using 50 AI models, available to over 40 million people in 16 Russian regions. In 2020 Sber and Skoltech signed a deal to create an AI ecosystem for Russian healthcare, where SberMedAI would act as the operator (refer to "Technology to market" section).
- CyberPhysics (Professor Ighor Uzhinsky, Dr. Sergey Nikolaev, Dr. Mikhail Gusev) develops a no-code platform for industrial

asset management and production optimization by means of combined physics-based and ML modelling. Opportunities provided by the platform include monitoring of industrial equipment condition, early detection of defects and identification of its causes, modeling and evaluating economic efficiency of various operational scenarios, and forecasting production processes, optimization, and management. In 2020 the company got the first investments, hired developers, released a MVP, implemented pilot projects, and signed several contracts.

• Labadvance (Professor Alexey Cheremisin, Evgeny Shilov, PhD Petroleum Engineering) helps petroleum operators and upstream chemical providers to optimize oil recovery methods, evaluate efficiency of different chemicals, and do numerical modeling of the microfluidic tests. By using artificial copies of rock samples, the company developed a faster approach for EOR, SCAL, and PVT tests. The proprietary microfluidic platform for laboratory tests in reservoir conditions was designed and manufactured. Microfluidic assembly was developed.

- PICsTech (Professor Arkady Shipulin, Professor Franko Küppers, Dr.Sergey Kontorov) develops a library of components for designing photonic integrated circuits on various technological platforms. These components can be used in various fields, including communication systems, sensors, radio photonics, and quantum devices. The commercialization is planned through provision of development and research services for nanofabs, companies and universities.
- Radiology Assistance Laboratories (IRA Labs) (Professor Mikhail Belyaev) helps to improve quality of CT and MRT and reduce costs and time of its description. The platform uses AI and includes the following modules: assessing the quality of scanning, intelligent noise reduction, comprehensive detection of the most common pathologies, and formalization of significant

findings description in order to automate protocols' completion. The launched pilot relates to the analysis of CT of the chest to detect SARS-Cov2 pneumonia patients.

- XREADY LAB (Khuram Pirov, PhD **Computational and Data Science** and Engineering) aims to increase users' engagement in STEM subjects via interactive VR simulations. The company builds interactive **3D** educational laboratories for schools and universities with proprietary intelligent algorithms for reconstruction and error tracking. Its algorithms reduce the cost of developing models for remote laboratories, as well as games in virtual reality with subsequent integration into existing educational systems. In 2020 XREADY LAB opened a VR class with Skoltech.
- K-Plus (Polina Morozova, Natalia Katorova, PhD Materials Science and Engineering) develops potassium-ion batteries, a nextgeneration technology with twice lower price of stored energy with a similar lifetime and reliability. The first prototypes of cells have been created and successfully tested, a



The use of modern technologies in healthcare is a key to providing accessible quality healthcare services for the benefit of the medical community and patients. The SberMedAI employs top-notch professionals who will help achieve significant progress in healthcare.

Olga Golodets, Deputy Chairman of the Executive Board, Sber

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procedure has been developed for obtaining anode carbon material and cathode material based on complex inorganic potassiumcontained compound, and assembling the main components into the battery.

Startups business development

The companies established in the previous years continued business development. 01Mathematics Online received a Skolkovo grant (27.7 mln Rub). Additive Production Group raised 8.5 mln Rub of venture investments. Inspector Cloud attracted 0,5 million USD investments from the OKS Group. Cryptochemistry reached the final of the competition at the Riga **Commercialization Reactor business** incubator, following which a joint legal entity was created with Latvian entrepreneurs and investments of 70k €. T-Tech signed an investment agreement with the Industrial Park of Innovations (Chelyabinsk) for construction of industrial complex for production of plastic profiles and other products using pultruded technology. Tsuru, Mig, Anisoprint and other companies successfully drove sales and widened their market presence. In 2020, supported by the CEI, Skoltech startups gained over 140 mln Rub (selling their products and technology, fundraising).

Highlights of IP portfolio

The patent filing since 2013 reached 205 applications in total, including

trademarks, software and database registrations. In 2020 Skoltech submitted 68 applications, 46 patents have been granted (applications submitted in 2018 – 2020).

Jointly owned patents resulted from cross-institutional research projects:

- Ohio State University (US), PCT/ RU2020/050089, Artificial Intelligence Trained with Optical Mapping to Improve Detection of Cardiac Arrhythmia Sources
- MIT (US), RU2020111517, Composition and methods for inhibition of the Arg/N-degron pathway
- MSUMD (RU), RU2020113200 Method for graphic registration of the trajectory of the lower jaw head based on ultrasound
- SUAI (RU), RU2020136915 Method for measuring the duration of individual steps of the left and right feet

First "quantum" patents were submitted for inventions originated from CPQM and CDISE:

- RU2021100138, Modeling of planar lattices of arbitrary geometry using polaritons in the framework of the variational approach (Professor Jacob Biamonte, Dr. Alexis Askitopoulos)
- RU2020129915, Polariton simulator (Professor Pavlos Lagoudakis, Dr. Sergey Alyatkin, Dr. Alexis Askitopoulos)
- 2020137077, Method for switching the macroscopic state of polaritons using a single photon, inventors (Professor Pavlos Lagoudakis Dr. Anton Zasedatelev).

Skoltech received certificates of state registration for three protocol stack software, functioning at the base station of 5G pilot zone in Skolkovo. The software is compliant with specifications and recommendations of the 3GPP consortium, and OpenRAN standards. Two Skoltech patents were included in the Rospatent list of "100 best Russian

- inventions" for the second half of 2020: • "ANODE FOR POTASSIUM-ION BATTERIES" (RU2731884C1) (Professor Artem Abakumov, Professor Keith Stevenson, Elena Abramova, Dmitry Rupasov, Natalia Katorova, and Polina Morozova)
- "NANO- AND MICROPARTICLES FOR ISOLATING SPECIFIC SUBPOPULATIONS OF EXOSOMES AND ANALYSIS THEREOF" (RU2733884C1) (Professor Dmitry Gorin, Dr. Alexey Yashchenok, Dr. Vasiliy Chernyshev, Polina Rudakovskaya, Anastasiia Merdalimova in collaboration with Laboratory of Molecular Immunology, Institute of Bioorganic Chemistry RAS). Besides maintaining excellence in biomed and engineering technologies through the past licensing agreements, technology licensing expanded to IT with agreements for recently developed and registered software solutions for COVID detection. estimation of vegetation height and power industry prognostic tools. Results of direct licensing revenue (IPonly) 2020 include 8 new contracts (5.16 mln Rub of fixed charges), 4 are subject of royalty on sales, licensing income totaled 4.2 mln Rub.

The licensing agreements included:

- Two non-exclusive license agreements for a software to estimate green vegetation height by monocular multispectral satellite imagery with submeter per pixel spatial resolution. Aeronet Lab at Skoltech introduced a solution for estimating height of green vegetation using satellite imagery and ML. Registered software solution was licensed to joint-stock company "OPDS" in exchange for royalty on sales that resulted in 3 mln Rub of licensing revenue in 2020; a second license was granted to Skoltech startup LLC "Geoalert" for 60% royalty from income.
- Exclusive license agreement for a computer program for automatic classification and segmentation of COVID-19 focuses on chest computed tomography images. Licensed to LLC "Intelligent Radiology Assistant Laboratories" for 3% royalty from income.
- Non-exclusive license agreement for a software complex for monitoring and forecasting the technical state of the GTPP Subsystems. The program is designed to automate functions of monitoring and predicting technical state of gas turbine power generating equipment based on mathematical models of subsystems of mobile gas turbine plants and machine learning models. Licensed to "Mobile GTES" for 5% of royalty.

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Professional training, advisory services

Professional training programs

The pandemic influenced the national professional training market. Like many other universities working in this sector, Skoltech was challenged to work online.

The programs were delivered to Sber corporate university, Gazprom Neft, Russian Railways, ILIM, Belorusneft, Lukoil, and others.

The success story here was a professional training program "Digital Economy and New Technologies" designed to RUSNANO top-management. The program was delivered by faculty of eight Centers, ending with a workshop of Prof. Alessandro Golkar on technology roadmapping based on the example of hydrogen technologies.

The thematic of other programs covered predominantly data science (digital technologies, artificial intelligence, Internet of Things, intelligent embedded systems, blockchain).

Advising on national programs

Skoltech faculty and staff supported a number of large-scale science and technology initiatives and projects by participating in expert sessions, working groups, preparing analytical reviews.

Skoltech involvement in the Digital Economy program was marked with expert participation in the working groups "Artificial Intelligence" and "Digital Technologies". The groups were set to form a basis for collection and publishing data by state executive authorities and state-owned companies necessary to create products, solutions and services using AI technologies, as well as to collect proposals for roadmaps on developing digital technologies in Russia. Skoltech participates in implementation of the Prospective standardization program in the area of Artificial Intelligence for 2021 - 2024, supporting the federal project "Artificial Intelligence". In

particular, Skoltech is presented in the subcommittee "Artificial Intelligence" (SC 42). Also, Skoltech is a member of the standardization committees of Federal Agency on Technical Regulating and Metrology (working group "Quality of AI systems", working group "Basic standards", working group "AI in education"). **Skoltech Analytical Department on** Science & Technology Development shared expertise on organization of monitoring and evaluation of large programs, support for companies during coronavirus, analysis of implementation of the National Strategy for Science and Technology Development (Ministry of Economic Development), national project "Science" / "Science and universities" (Ministry of Science and Higher Education), a methodology for evaluating and updating TechNET roadmap (National Technology Initiative).

Skoltech represented Russia in a few events of the BRICS initiatives: a session of a working group in Biomed (issues related to collaboration on COVID-19), and a session of the working group in Photonics (harmonization of national standards and regulations in the area of Photonics, BRICS Virtual Institute of Photonics).

Roadmaps, white papers

A number of recommendations, white papers were developed by the Analytical Department on Science & Technology Development, including:

- suggestions on the roadmap for development of "5G Mobile Communication Networks" up to 2024,
- financial micromodels to support investment proposal to MTS based on Skoltech 5G software developments ("Digital Economy" program).
- White Paper on perspective directions in Neuro technologies.
- support for collaboration of Skoltech and InEnergy Group in the field of electric vehicles and energy storage systems, including presentations, financial modelling and marketing analytics in support to InEnergy project of large-scale Li-ion plant with domestic cathode materials manufacturing.



Skoltech delivered a system engineering course for our team. The course was tailored to specifics of our company and ongoing R&D projects; it was important for us to study based on the company real cases and gain knowledge applicable in ongoing activities.

Alexey Tarasenko, Head of programs for technology development Engineering Center for hard-to-recover reserves, "Gazpromneft-Technology partnerships"



Local, national and global standing

Partnership network

Local standing: Skolkovo ecosystem and Big Skolkovo

Being a part of the Skolkovo ecosystem, Skoltech pursues opportunities to collaborate and contribute in multiple aspects. Leveraging the Skolkovo "testbed", Skoltech and a national telecom giant MTS launched a pilot 5G network. Skoltech faculty, researchers and students fueled the ecosystem with science intense startups, creating new jobs. The cooperation with the Gymnasium was supported with various formats tailored for kids' scientific interests. No less important is to note that Skoltech is an active citizen of the ecosystem – more than 110 families of Skoltech personnel live in the residences, being the pioneers in accommodating new apartments. The Big Skolkovo partnership with the Moscow School of Management and New Economic School was marked with Practicum and a Startup Academy attended by Skoltech students, STEM oriented program "MOOVE", where faculty served as academic partners and delivered technology oriented courses.



Joining national consortia of universities

The unique cooperation agreement was signed with the Government of Republic of Bashkortostan and Bashkir universities on establishing a national level technology center level. The center will focus on development and implementation of technologies in digital and green chemistry, energy, biomedicine and genetics, advanced manufacturing and engineering, environmental studies. Skoltech co-founded the New League of Universities, along with the National Economic School, Moscow School of Social and **Economic Sciences**, European University at Saint Petersburg. The League will advance multidisciplinary research, joint educational programs, contribute to national level policy making. The parties have already started collaboration (refer to section "Teaching and Learning").

Advancing international partnerships

The MIT Phase III was launched with NGP open calls and calls for seed funding for innovation projects (also refer to "Research excellence" section). The 4th Annual Workshop of Skoltech-MIT Next Generation Program opened Phase III briefing on plans for research and academic exchange. The strategic partnership with TU Munich was kicked-off with the visit of Skoltech delegation to have meetings with Prof. Dr. Thomas F. Hofmann, President of TU Munich. Following the visit, the joint workshop in the field of energy was held between CEST faculty and the research aroup of Prof. Dr. Thomas Hamacher (Munich School of Engineering) to define areas of mutual interest.

A number of faculty-to-faculty collaborations brought partnership agreements with Eindhoven University of Technology, Politecnico di Torino, University of Padua, University of Iowa, RIKEN, Universidad Politecnica de Madrid.

To promote R&D expertise, Skoltech entered international technology consortia – O-RAN Alliance, focusing on standardization of elements of the 5G radio access network architecture and the Telecom Infra Project, which is a global community of companies accelerating development and deployment of open, disaggregated, and standards-based technology solutions.



President Alexander Kuleshov, Provost Keith Stevenson with the President of TU Munich Prof. Dr. Thomas F. Hofmann



Left to right: Counsel (Office of MIT General Counsel) Matthew Fucci, Assistant Director of MIT Skoltech Program Deliana Ernst, VP International Business Affairs and IP Lawrence Stein, VP Development Alexander Safonov, MIT Associate Provost, Skoltech Board member Richard Lester, Skoltech Board member Pekka Viljakainen, Provost Keith Stevenson, Faculty lead of MIT Skoltech Program Bruce Tidor. 89

Wider community engagement

Being committed to bringing value to societal development, Skoltech community is actively engaged in activities for promoting cutting-edge knowledge. The program for school kids included open lectures in biology (Letovo school), the basic course in research ("Polytech for teenagers"), the online course on RNA (Politech for kids), and other activities. "Nonformal lectures in Physics", a joint project of Skoltech and Moscow Institute of Physics and Technology, were delivered to 240 participants from national STEM schools and universities.



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Skoltech Lecture hub attracted more than 5 000 views in real time, and 500 000 views in Youtube and Vk channels. More than 30 lectures in modern platforms for science promotion, such as Arhe, Tochka kipeniya, Polit.ru, Skolkovo Technopark were delivered. Select examples:

Prof. Maxim Fedorov	Artificial Intelligence vs COVID-19
Prof. Evgeny Burnaev	Hype or hero: what do deep neural networks and computer vision have in stock for us?
Prof. Yury Kostyukevich	Omics technologies: detecting illegal drug use by weighing the suspect. How are illicit drugs, doping and Novichok detected in blood samples?
Prof. Alexey Zaytsev	Terminators by Google and Yandex
Prof. Maria Pukalchik	Artificial Intelligence: here comes smart farming
Dr. Petr Prokofiev	5G world. Economic implications of 5G
Prof. Vladimir Antonov	Nano technology: capabilities and prospects
Prof. Dmitry Gorin	Switch on your imagination and embark on a quest to the microworld
Prof. Anton Ivanov	Mysteries of the red planet. Space revolutionaries. How small satellites have changed exploration of space
Prof. Tatiana Podladchikova	Space weather: embraced by the Sun
Prof. Mikhail Gelfand	"Les Liaisons Dangereuses", or the history of the human genome: Cro-Magnons, Neanderthals and Denisovans
Prof. Konstantin Lukyanov	The secrets of the fluorescent proteins
Prof. Philipp Khaitovich	Wandering through the maze of the human brain. Evolution and the human brain
Prof. Mikhail Belyaev	Artificial intelligence in medicine: who will make a diagnosis 10 years from now?
Prof. Dmitry Koroteev	"Digital oil": myth or reality?
Prof. Alexey Cheremisin	Is there enough oil in the world?
Dr. Mikhail Gusev	Digital Twins: Harnessing Industry 4.0.
Prof. Dmitry Kulish	New technology "unicorns" that sprang up as a result of the pandemic
Dr. Grigory Kabatiansky	Code- and lattice-based postquantum cryptography

The Planet Watch program targeting the best high school students was implemented jointly with Sirius, Bortnik Fund and Roscosmos, attracting more than 20000 participants from Russia. The online lectures "Planet Watch: Space Experiments" have been delivered to establish cubesat-based scienceand-education experiments.

Growing visibility

Expansion of media coverage in Russia and abroad

Skoltech speakers joined researchers worldwide giving expert commentaries on scientific and societal responses to COVID-19, featured in BBC, The Wall Street Journal, Financial Times, Washington Post, Observador, Il Messaggero, RBC, Kommersant, and other media. News on COVID-19 genomic epidemiology in Russia entered the top Yandex most read news (more than 250 publications and about 20 interviews were released in Russian and international press during one day). The media geography was expanded: Skoltech was featured in media

resources in Australia, Brazil, Chile, China, Indonesia, Japan, New Zealand, Peru, Poland, Portugal, Spain, Sweden, Taiwan, etc. Skoltech became a newsmaker on special occasions: an investigation of a new Yamal crater, the disinfection robot UltraBot, the launch of a 5G zone, etc. and was mentioned in top international media: The New York Times, CNN, BBC, The Sun, Newsweek, ABC, National Geographic, AP, TASS, RIA Novosti, RBC, Rossiyskaya Gazeta, Izvestiya, VC, Vedomosti, N+1, etc. Compared to 2019, 50% more press releases based on publications of faculty and researchers were distributed on average.



Médicos especialistas en trajes protectores esperan a pacientes en el complejo hospitalario para pacientes con la enfermedad en el asentamiento de Kommunarka - EFE

El rastreo efectuado indica que el coronavirus llegó a Rusia desde China, Europa y Arabia Saudí

 Según el Instituto de Ciencia y Tecnología de Skólkovo (Skoltech), en el extrarradio de Moscú, fueron 67 «pacientes cero» (llegados desde fuera del país) los que, a partir de febrero y marzo, propagaron la Covid-19 por el país



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Land in Russia's Arctic Blows 'Like a Bottle of Champagne'

Since finding the first crater in 2014, Russian scientists have documented 16 more explosions in the Arctic caused by gas trapped in thawing permafrost.





In August 2020, the RAS Institute of Oil and Gas Problems, supported by the local Yamal authorities, conducted a major expedition to the new crater. Skoltech researchers were part of the final stages of that expedition. Credit: Evgeny Chuvilin



20.07.2020, 10:24 «Сколтех»: коронавирус завезли в Россию из Европы

* ■ * f ¥ % 7 Ø

Коронавирус был завезен в Россию не из Китая, а из Европы, выяснили ученые «Сколтеха» совместно с другими исследователями. На данный момент в России существует не менее девяти вариантов вируса, которых нет в других странах. Как и предполагалось, завезли коронавирус в страну в конце февраля—начале марта.

Работу провели исследователи из Центра наук о жизни Сколковского института науки и технологий, Высшей школы экономики, НИН гриппа имени А. А. Смородинцева и Института проблем передачи информации имени А. А. Харкевича под руководством профессора «Сколтеха» Георгия Базыкина.

«Сопоставляя генетические данные по вирусам, циркулирующим на территории РФ, с данными о передвижении населения, ученые сделали вывод,

Marketing & brand

The year 2020 marked establishment of the centralized marketing service. Skoltech community now has all services aimed to promote events and activities: design of materials, digital advertising campaigns, branding and content management, special websites and landing pages. It is worth noting that a strong online marketing expertise (contextual/targeted ads in Google and Yandex search engines, social media, webinars, a system of landing pages, email marketing) ensured an easy, quick and effective transition to the online formats. Thanks to these marketing efforts, all Skoltech events (schools, conferences, outreach and promotion) evidenced a high attendance rate. Remarkable examples are the MSc and PhD admission campaign (also refer to section "Student and alumni community") and Summer School of Machine Learning (growth of applications, 28% increase in admission selectivity compared to 2019)

The unified Skoltech brand identity standards related to promo materials, formal templates and elements were designed and released in a user friendly unique, interactive website format brand.skoltech.ru.



Social media

In 2020, all Skoltech social media platforms have grown significantly.

The increased number of followers and their deeper involvement is strengthening brand recognition and loyalty.

0

+72.5% followers (4.0k vs 6.9k)

(in

+26.7% followers (5.6k vs 7.1k)

f

+41% followers (9.5k vs 13.4k)

+163% followers (1.25k vs 3.29K) +199.781k views W

+28.3% followers (17.3k vs 22.2k)



+17.8% followers (2.8k vs 3.3k followers) +388 mentions

95

Internal communication: online digests

Weekly email digests for Skoltech students and staff were launched. Each digest briefs on community news, results of research, team achievements, upcoming events, educational and entertaining purpose materials from Skoltech and Skolkovo ecosystem. This allowed to optimize and consolidate scattered streams of information and streamline Skoltech official email communication channel. All other mass emails circulated to faculty, research personnel and all staff are designed in a unified standard.

New horizons of media projects

Utilizing expertise in media projects completed in previous years, Skoltech presented several new projects. The Forefront of Physics, a project with Ogoniok Magazine, continuing the Mathematical Walks, is a collection of interviews with prominent Russian origin physicists on topics that may completely change the world. The Mathematical Walks appears in Chinese language (2021), the Anhui Educational Publishing House will promote the book to other countries of the Southeast Asia region. Dedicated to the 10th anniversary of the Skolkovo Foundation, a special edition of Almanac featured highlights of Skoltech, created as a part of the Skolkovo project to create.





Financial performance

Financial Highlights³

(in millions of rubles)	2016	2017	2018	2019	2020
T . 16 P	(100	(520	7.00/	0.010	0.00.4
lotal funding	0 4 3 8	0 339	/ 026	8313	8 984
Operating expenses	3 626	4 084	5 557	6 620	7 204
Capital expenses	2 215	1 794	689	800	1 082
Endowment net assets	4 558	4 719	4 618	4 775	4 787

The results for 2020 Fiscal year ending are better than Skoltech expected facing COVID-19 crisis. Efforts to restrain spending helped to mitigate the substantial negative financial impact of pandemic and economic situation, including costs of work safety that will be continued into 2021. Skoltech managed operational and financial risks and made significant progress in building a sustainable financial model.

Funding

In Fiscal Year 2020, Skoltech received 8 984 mln. Rub from various sources, 8% more than in 2019. The structure of funding did not change significantly in comparison with 2019. Skolkovo Foundation Grant (6 637 mln Rub) is the largest source of funding. Attracted funding increased by 16% (251 mln Rub) in comparison to 2019 mostly due to a larger income from grants and contracts that projected to be stable despite of uncertainties of COVID-19.

(in millions of rubles)	2019	2020	Change, %
Attracted Funding	1 589	1 840	16%
Sponsored research contracts	1 193	1 276	7%
Grants	379	544	44%
Shared Facilities	17	20	20%

Expenses

The expenditures totaled 8 286 mln Rub, including capital investment projects. Expenditure comprises the following primary activities: academic excellence and value generation, student support and development, operations, campus, governance and management.





The results for 2020 fiscal year ending are better than Skoltech expected facing COVID-19 crisis. Efforts to restrain spending helped to mitigate the substantial negative financial impact of pandemic and economic situation, including costs of work safety that will be continued into 2021. Skoltech managed operational and financial risks and made significant progress in building a sustainable financial model.

Tatyana Zakharova, Vice President for Finance and Operations

³ Financial results presented based on a cash approach.

Operating expenses

In 2020, the personnel remained a primary value, staff costs represent 56% of total expenses. Personnel expenses include salaries, compulsory social security contributions, bonuses, medical insurance, reimbursement of accommodation and benefits in kind. The staff costs increased by 424 mln Rub (12%) compared to 2019 due to a growth of personnel by 19%. This is mainly due to hiring staff to support intense contract activities. Scholarship and student support decreased by 28 mln Rub or 4% in comparison to 2019 due to COVID restrictions influenced on the academic mobility. The cohort increased at 1%, reaching 1068 students as of the end of 2020.

Funding of joint research programs with world's leading universities remained the priority of Skoltech agenda. In 2020, 570 mln Rub was spent on further extension of research initiatives, this is 195 mln Rub (52%) more than in 2019. The increase is mainly due to the payment of 478 mln Rub under the long-term research agreement with MIT. 53.9 mln Rub was spent to finance NGP projects and Biomedical initiative programs. Payments to support research projects with other partners totaled 38.6 mln Rub.

Campus rent, utilities and maintenance expenses represent 11% (770 mln Rub) of total expenditures and include costs for repair and maintenance of engineering systems, utilities, cleaning and security services. The construction and relocation of laboratories to campus continued, resulted in 9% increase of expenses.

Other operating expenses included events and business trips, software and IT equipment maintenance, operating rent of equipment, PR and marketing, library, taxes and charges. The decrease of expenses of the group by 116 mln. Rub is explained by cancellation of majority of events and business trips due to the pandemic.

100

⁴ Headcount.





Capital investments

Skoltech is committed to a longterm expenditure plan, implying construction of the campus. In 2020 the capital expenditure amounted to 1 082 mln Rub, including 438 mln Rub on research equipment and software, 543 mln Rub on labs construction, 101 mln Rub on furniture. The total spending on construction of the new campus in 2016 – 2020 is 2 018 mln Rub, including engineering equipment and furniture.



Spent on Equipment and Software Spent on Labs construction Spent on furniture

Endowment

The Endowment Fund has a longterm investment strategy to enhance Skoltech financial independence and support implementation of the strategy. The Endowment Fund investment policy primarily focuses on ensuring reliability, liquidity, yield and diversification of investments. According to the Investment Declaration approved by the Endowment Foundation Management Board, investments can be made in national state bonds, national corporate bonds (defined in a specified list) and deposits in Russian Rubles in the state-owned banks. Endowment funds are managed by professional asset management companies, including Management Company Alfa Capital and Management Company VTB Capital Asset Management. The Endowment Fund as of 31 December 2020 amounts to 4 787 mln Rub (4 775 mln Rub as of 31 December 2019). In 2020, the Endowment Fund received 100 mln Rub donation from Sber (also refer to the section "Governance and management"). As of December 31, 2020 the following assets comprise the Endowment Fund portfolio:

102

	Tot	al
Net assets	Mln Rub	%
Russian government bonds	924	19%
Corporate bonds	3 756	79 %
Cash and Cash Equivalents	107	2%
Other receivables/payables	-0,1	0%
Total	4 787	100%

Analysis of the structure of the Endowment Fund portfolio (including bonds, cash in bank) as at 31 December 2020 shows that Corporate bonds represent 79% (31 December 2019: 89%) of the total portfolio. Financial results from the management companies' investment activity in 2020 is lower by 159 mln Rub than those of 2019 (481 mln Rub) due to market situation in 2020.

	2019	2020	Change
Annual return, mln RUB	481	322	-159
Annual return, %	10,67%	6,98%	-3,69%



Measuring progress

Key indicators of development

The composition and targets
of Skoltech key indicators of
development are defined by
the Strategic Action Plan, grant
agreement with the Skolkovo
Foundation, and the national
program "Economic Development
and Innovative Economy" ("national

program") to measure Skoltech performance in academic excellence & value generation. Annual and interim reports on achieving the targets are submitted to the Board of Trustees, Skolkovo Foundation, and the Ministry of Finance as a coordinator of the national program.

1. Publications indexed in WoS, Scopus

Skoltech continued to maintain the highest quality of the publication output, slightly exceeding the target set for 2020 (4.2). In 2020, faculty published 694 papers, including 96 papers in the most prestigious Nature Index journals. The total publication output of faculty, researchers and students is presented by 1131 papers, 63% of which are in Q1 journals.

2016	4.4
2017	5.6
2018	5.8
2019	6.3

2020 6.4

The indicator is a direct measure of faculty research output, calculated as a ratio of papers indexed in WoS, Scopus to the average faculty headcount⁵ as of the end of the year.

⁵ Calculated as the average faculty headcount for the reporting year (108,48 as of Dec 31, 2020).
2019	252
2018	176
2017	92
2016	81
	2016 2017 2018

The indicator tracks annual graduation, which relates to the target of the national program to have 1000 graduates in 2020 (cumulative).

3. Graduates' employment in	2016	67%
the national innovation sector	2017	67%
	2018	69%
Despite the job market standing, influenced by the pandemic, 70% of the graduation class 2020 are	2019	70%
pursuing career paths in the national innovation sector. The vast majority (54%) has been employed in high tech companies, research institutions	2020	70 %
startups, while 17% are continuing for PhD in Skoltech (the shares are rounded).		
· ·		

Accounting Skoltech goal to educate future leaders in science, business and entrepreneurship, the indicator tracks graduates' employability focusing on the national innovation sector, defined as high-tech companies, research institutions, Skolkovo startups or PhD studies in Skoltech.

4. Patent applications per faculty	2016	NA
	2017	0.2
The IP applications in 2020 grew compared with	2018	0.5
results of 2019. The majority of applications (46%) refer to Data Science and Artificial Intelligence	2019	0.4
target domain. Considering the type of IP applications, the "invention" type dominates.	2020	0.6

The indicator measures a number of patent applications submitted to the average faculty headcount as of the end of the year. The indicator is tracked from 2017, when Skoltech became a fully functional university.

in 2020. 42% of companies are founded (co- founded) by students or alumni	2020	57
The cumulative number of Skoltech associated	2019	40
	2018	26
ecosystem (cumulative)	2017	19
5. Skoltech startups in Skolkovo	2016	12

The indicator measures a cumulative number of Skoltech associated startups, established by faculty, researchers, students, or alumni, with a status of Skolkovo resident. Included in the national program to track entrepreneurial activities and Skoltech contribution to the ecosystem.

2018	1595
2018	1595
2010	1112
0010	1112
2017	554.7
2016	348
2	2016 2017

The indicator tracks Skoltech efficiency in raising external funds (excl. Skolkovo grant) – grants and contracts, IP sales, licensing. The actual result is calculated as committed funds under contracts (non-cash method).

7. External funding	2016	15%
(% in the annual budget)	2017	20%
	2018	25%
Skoltech outperformed the target of 2020 (25%).	2019	26.5%
The major income (16%) has been received under		
industry sponsored projects, and grants (7%). Other sources of income included cash received from consulting, professional training, services of shared facilities, sublease and endowment.	2020	29.6 %

The indicator measures Skoltech income received under grants, R&D contracts, professional training contracts, licensing agreements, and endowment to Skoltech total expenses (excl. capital expenditures for campus construction and investments into equipment). The calculation is made by cash received.

Common data set 2020

Human capital

Skoltech personnel



110

Generation Z: born in 1997 – 2012 Generation Y: born in 1981 – 1996 Generation X: born in 1965 – 1980

% of non-academic personnel



111



Academic personnel by target domains and Centers



Faculty by rank



112

Faculty by type of employment



Student cohort



113

Student cohort by level of studies



Students by gender









Internationals in cohort by region





MSc and PhD intake by university





MSc and PhD graduates (cumulative)



117



Annual MSc and PhD graduation

Graduation class 2020

MSc program	Graduates
Data Science	95
Information Science and Technology	25
Life Sciences	39
Advanced Manufacturing Technologies	19
Materials Science	21
Petroleum Engineering	23
Space and Engineering Systems	34
Energy Systems	14
Photonics and Quantum Materials	24
Mathematical and Theoretical Physics	8
Total	302

PhD program	Graduates
Computational and Data Science and Engineering	14
Life Sciences	7
Materials Science and Engineering	7
Petroleum Engineering	8
Engineering Systems	13
Physics	9
Mathematics and Mechanics	5
Total	63

Graduation class 2020 career paths



Snapshot for "Industry Russia"



Skoltech alumni global map





Skoltech alumni global map (Europe)



All alumni per target domains



Excellence making impact

Annual publication output



As of Jan 22, 2021 the total Skoltech affiliated output (2020) indexed in Web of Science, Scopus, is 1131. 57% of papers are in co-authorship with international partners.



91 Skoltech affiliated papers with a share 20.23 are shown in Skoltech profile in Nature Index for the period December 2019 – November 2020¹ (source: www.natureindex.com). Most publications are result of Skoltech international collaborations with Aalto, Max Planck Institutes, MIT, CNRS and other institutions.

Nature Index output

Publication output collaborations



Top international collaborations



The charts demonstrate Skoltech publication output as indexed in Scopus for the period of 2016 – 2020 (Source: SciVal as of March 15, 2021)

Annual grant funding (mln Rub)



126

Grant portfolio (2020 – 2023) by area



The chart demonstrates grant funding in a classification used by Office of Sponsored Research. The total amount of funding is 1.4 bln Rub.

Grants (2020 – 2023) by Centers (mln Rub)



Grants (2020 – 2023) by source (mln Rub)



R&D funding (annual, mln Rub)



R&D funding by source (mln Rub)



R&D funding (2020 - 2023) by Centers (mln Rub)



R&D funding 2020 - 2023 by focus area (mln Rub)



The chart demonstrates funding in a classification assigned by the R&D contract office. The total amount of funding 2020 – 2023 is 2.5 bln Rub.

Skoltech associated startups



130

Skoltech associated startups with Skolkovo residency



Patent activity overview



Patent applications 2020 by Centers



The total number of patent applications is 69.





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