Skolkovo
Institute of Science
and Technology

Skoltech

Skoltech Annual Report '23

About the Report

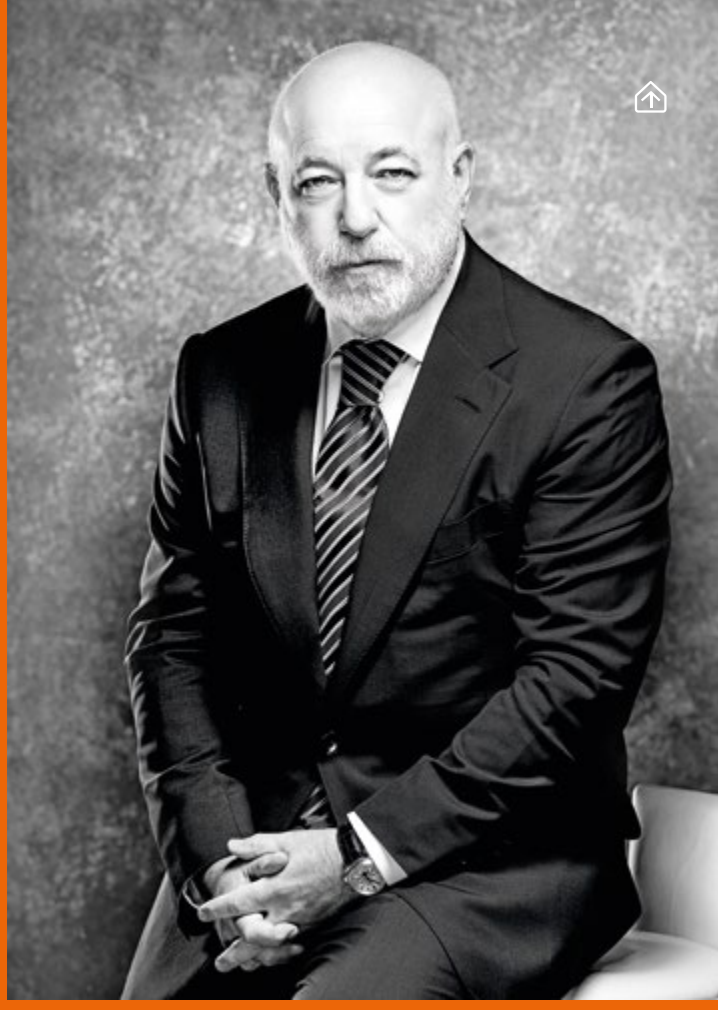
The Annual report is the main reporting document, presented to the Founders, Trustees, partners, and a wider audience. It summarizes basic information about Skoltech, highlights achieved under the Strategy (period of January 1 to December 31, 2023), and presents financial results which will be later confirmed by the independent auditor.

The Report is prepared following advanced practices for corporate reporting, and recommendations of experts shared at conferences for reporting organized by the largest Russian rating agency RAEX.

The Report was approved by the Board of Trustees on March 12, 2024.

Content

Message from the Chairman of the Board of Trustees



For Skoltech it was the year of transformation, development and confirming the position of one of leading technology universities capable to deliver expertise in areas crucial for Russian economy stability. All of this confirms, that the chosen strategy is reasonable and effective: to shorten a gap between fundamental and applied science, raise a new generation of specialists to create breakthroughs in research and develop real products.

Skoltech has proved to be a reliable R&D partner for the largest corporations and institutes, which target advanced development and leadership. Skoltech plays an important role in development of technologies in areas that will define the nation's economic profile and structure – Mobile Telecommunication, Artificial Intelligence, Energy Transition and New Materials. The first product, which is a fully locally developed base station of new generation, is ready for scaling and implementation. Next technology solutions are on the way: a number of Skoltech associated startups is growing while their technology level is confirmed by a growing number of investors ready to support ideas of students and graduates.

I am pleased to say that Skoltech successfully passed through turbulence and proved to be an important member of international academic community, strengthening, and enlarging a partnership network in advanced research areas. Cooperation with top universities in China and UAE is a sign of recognizing Skoltech results and a real breakthrough to future technologies.

All these achievements are the result of coordinated and dedicated work of our entire team, top notch faculty, students, and administration. Our faith in Skoltech mission proved to be stronger than any difficulties and artificially created obstacles.

With a launch of the first BSc program, a new era in Skoltech history has begun – we are growing and firmly continuing forward. Life showed that the chosen vector for development is correct – this means that rewards of our joint efforts will be significant. Without any doubt, Skoltech continues to be a leader in science and technology.

Viktor Vekselberg,
Chairman of the Board of Trustees

Message from the President

Skoltech was established a bit more than 10 years ago to develop competencies, that are missing or not widely presented, however crucial for Russia's technology and economic development. These goals should be addressed through a system of training world-class specialists, setting highly skilled teams of researchers, engineers, and students, capable to develop own technologies – and implement them. Today we can proudly say that Skoltech learned to solve these tasks and fully fulfills commitments.

Now about our results.

The 4/5G base station technology has been developed and transferred for production. It is important to note that the technology was transferred as three main components: design documentation, test and measuring equipment and a team of developers.

Our next product – technologies in energy storage systems.

We maintained a high level of research and showed results recognized in the academic community. These are awards 'Vyzov', 'AI Leaders', BRICS Prize, and 'Frontier of Science Award' in string theory and homological algebra.

We continued to shape the ecosystem of technological entrepreneurship which is based on ideas and technologies generated by faculty and students in the Centers and laboratories. The notable results include a growing number of student startups and Skolkovo residency startups, and attraction of investments.

There is plenty of work ahead. We fully understand strategic priorities and we are confident in what we are creating – for development of Skoltech, national economy and society.

Alexander Kuleshov,
President

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Introduction

About Skoltech

Skoltech was established in 2011 as an international institute of a new model in Russia – leading institute in chosen research and technology areas through excellence and impact on economy and society.

Skoltech model, Triple Helix, is grounded on Research, Technology, and Education. Research excellence allows to expand knowledge boundaries and define promising areas, attract talents, and shape world-class teams, cultivate intellectual scientific and technological environment. Technologies are not only about applied results, but also their transfer to production and, ultimately, to the market. Skoltech technological entrepreneurship ecosystem and the Skolkovo project as a whole are enablers to achieve this goal. Education means international level programs in advanced areas, delivered in a close integration with research and technology domains.

Skoltech pursues frontiers in Artificial Intelligence, Life Sciences, Agro, Advanced Materials and Engineering, Energy Efficiency and Energy Transition, Telecom, Photonics, and Advanced Studies. Research level is reflected in top ranking positions, publications in prestigious journals, national and international awards.

Skoltech sets up own technology development lines on the base of research infrastructure. Technology expertise is demanded as evidenced in the role in national programs, and multiple industry contracts. Many experimental developments have been brought to the market: a startup 'belt' includes more than 160 companies – in Skolkovo and beyond. Their annual revenue exceeds 1 billion rubles.

Skoltech has a full cycle of education in areas, where there is a shortage of specialists and further demand is forecasted. The portfolio, including professional trainings for industry, includes more than 60 programs.

Skoltech shares competencies with regions in Russia through partnership programs in technology, education and research. Recently, the project for providing expertise on the national project of world-class campuses was launched.

Skoltech social mission is about bringing knowledge to a wide young audience, to show importance of science and technology, as well as advancing a prestige of being a scientist or an engineer.

Purpose

Our Mission

Skoltech facilitates economy and societal development through academic and technology excellence and entrepreneurial spirit.

Strategy

Currently Skoltech is guided by Strategy 2021 – 2025.[1] In 2023, it was revised accounting for results of the first period (2021 – 2023), changes in the international context, new priorities in research and technology, and plans to expand the human capital program.

The goals for 2025 are focused on keeping the highest level of research, developing technologies which can be implemented in Russia in the shortest time. The program to train specialists in research and technology areas, where there is a shortage of experts will be enlarged.

Strategy targets are reflected in the system of KPIs.

[1] The first edition was approved in 2020.

Strategic KPI

Strategic KPI	Strategy cumulative result (2021–2025)
Papers in prestigious international journals and conferences	1500
Impact on the national economy (bln Rub)	>100
New startups[2]	95
Graduates	1700 ± 5%
Graduates in the national R&D sector	70%

[2] New companies, received Skolkovo residency or support from the institutes for development.

Year highlights

1 Tranfer of 4/5G technology to industry

Development of 4/5G base station production technology was completed – technology was transferred to industry. This was the first time, when Skoltech produced not only a prototype, but the product ready for a serial production. In this paradigm, the 'product' means design documentation, test and measuring equipment, and a team of developers.

2 Focus on national technology priorities

Focus on national technology priorities was sharpened by extension of role and involvement in federal programs for Modern and Advanced Mobile Communication networks, AI, Domestic Instrumentation, Energy Storage, Space systems and Services, Unmanned Aircraft Systems, Advanced Materials.

3 Recognition and awards

Excellence of faculty and students were appraised by national and international recognition and awards. 16 faculty appeared among top-2% of world's scientists in Stanford ranking. Prof. Lagoudakis and Prof. Alyatkin received 'VYZOV' Award. Prof. Finkelberg received the Frontiers of Science Awards at the International Congress of Fundamental Science. Prof. Korotin became the winner of 'AI Leaders' National award. Prof. Yudin received BRICS Young Innovator Prize. Anton Razzhigaev, Denis Kuznedelev, Nikita Gushchin, Aibek Alanov received Yandex ML Prize.

4 Complex for prototyping with support of the Moscow Government

The unique complex for prototyping of integrated photonics devices was launched with support of the Moscow Government. The complex allows to prototype elements, components and devices starting from telecom equipment and quantum key distribution systems to medical products, LIDARs and fiber-optic sensor systems.

5 6 startups in the list of top 100

6 Skoltech associated startups entered the 'top 100' of the national ranking of university startups, announced by the Ministry for Science and Higher Education.

6 Launch of baccalaureate

Skoltech baccalaureate was opened: first 22 students were enrolled to 'Materials for Energy Storage and Conversion' program.

7 Educational Initiative of the Year

MSc program 'Maths of Machine Learning' with the Higher School of Economics became the 'Educational Initiative of the Year' at the Data Fusion conference.

8 New faculty appointments and a return to development

2 open calls resulted in appointments of new faculty and, thus, allowed to resume a development track after 2022, when Skoltech lost faculty due to sanctions.

9 New members appointed to the Board

The General Meeting of Founders appointed 6 new members to the Board of Trustees. The Board approved the Strategy update and a revised KPI system.

10 Presence at key national forums

The technology results were appraised by the President of the Russian Federation at the national forums 'Future Technologies' and 'Russian Energy Week'.

Numbers at a glance

Year 2023

Research

240
publications in prestigious journals (top 10% SJR)

60%
publications with international partners (top 10% SJR)

91
grant projects conducted by research teams, 45 projects are led by young researchers

>90
laboratories with high-tech equipment

Technology and Innovation

3.4
bln Rub attracted funding[3]

745
mln Rub IP income

225
active items in IP portfolio

166
startups in Skoltech ecosystem

Education

22
programs in AI, Life Sciences, Agro, Advanced Materials and Engineering, Photonics and Telecom, Advanced Studies

2%
enrollment rate based on results of successful completion of entrance exams

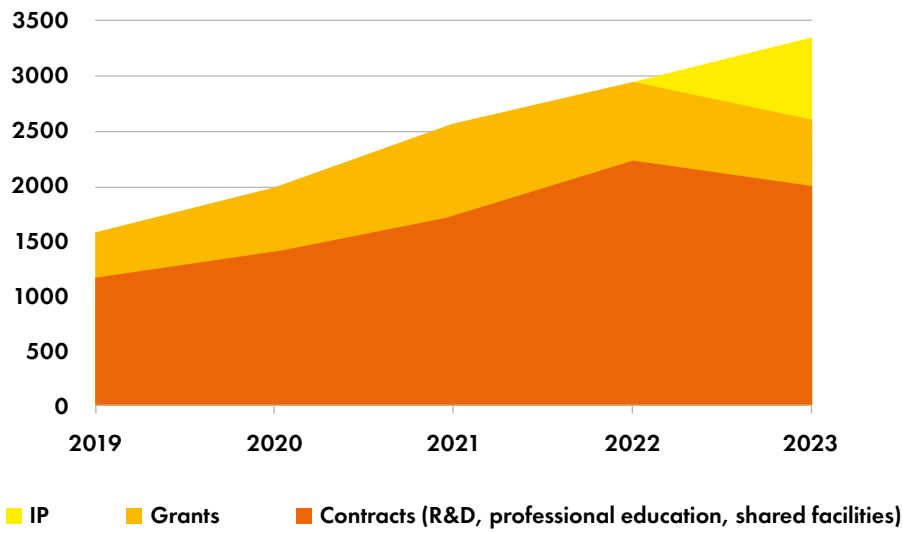
86
high-tech companies and startups where graduates 2023 are employed

42
professional education programs for R&D sector

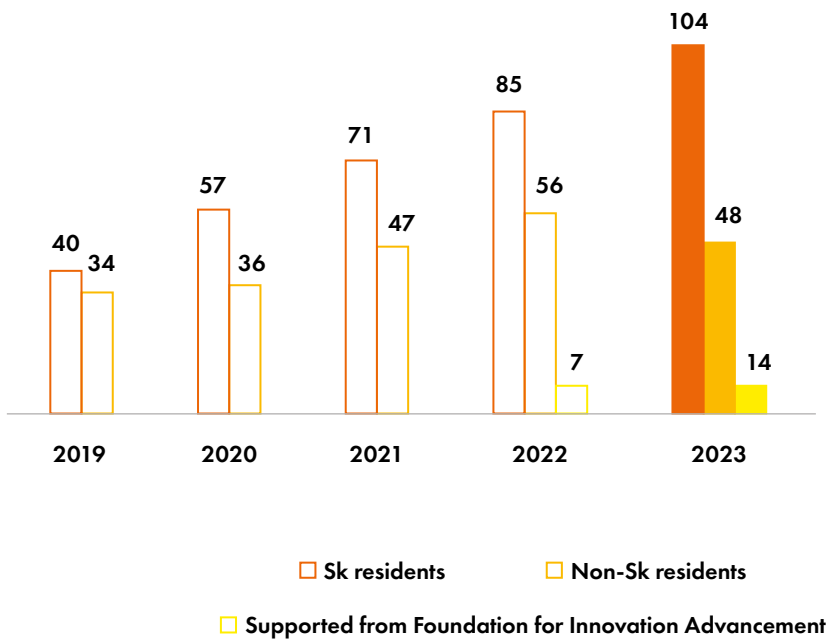
[3] R&D contracts, grants, professional education, IP.

Figures in trends

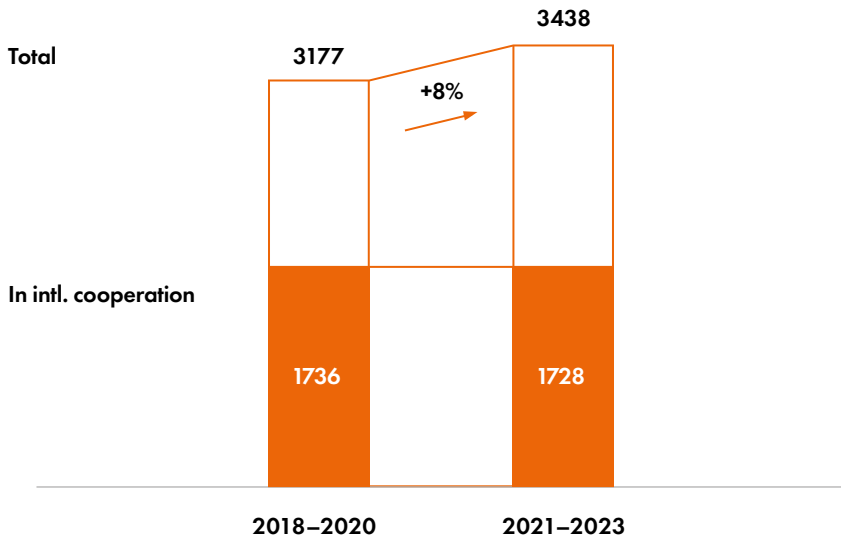
External funding (mln Rub)



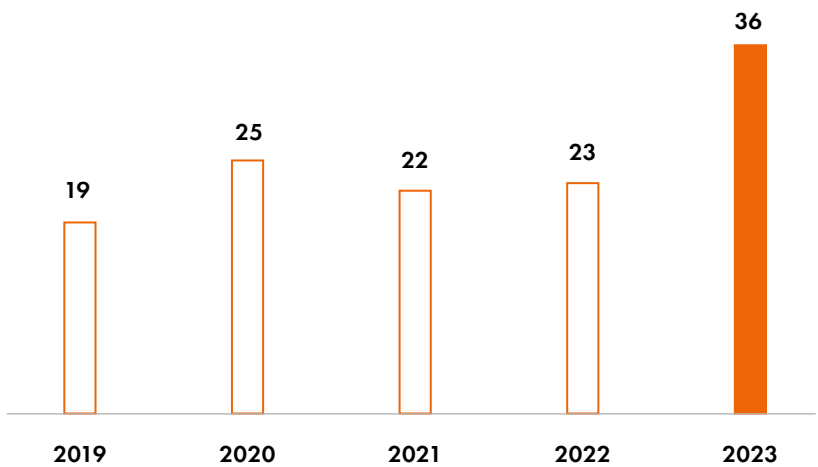
Skoltech associated startups (cumulative)



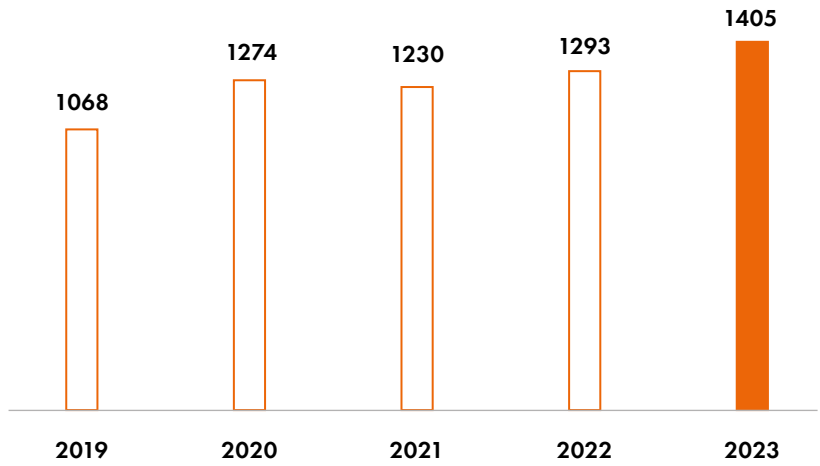
Publications in international cooperation



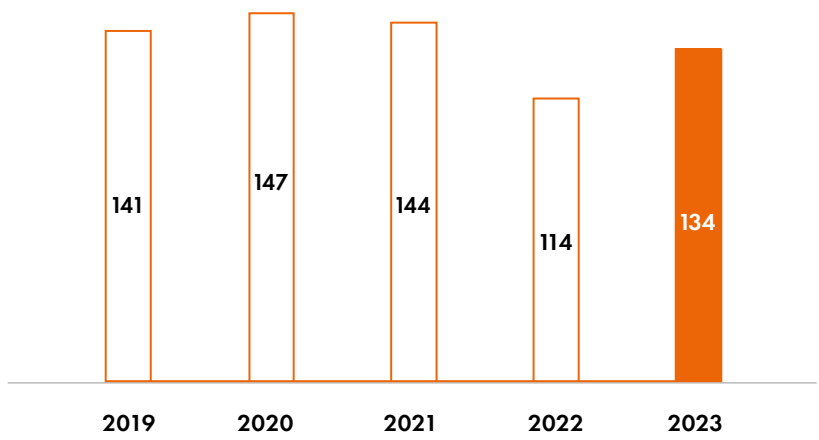
Publications at prestigious AI conferences (A*)



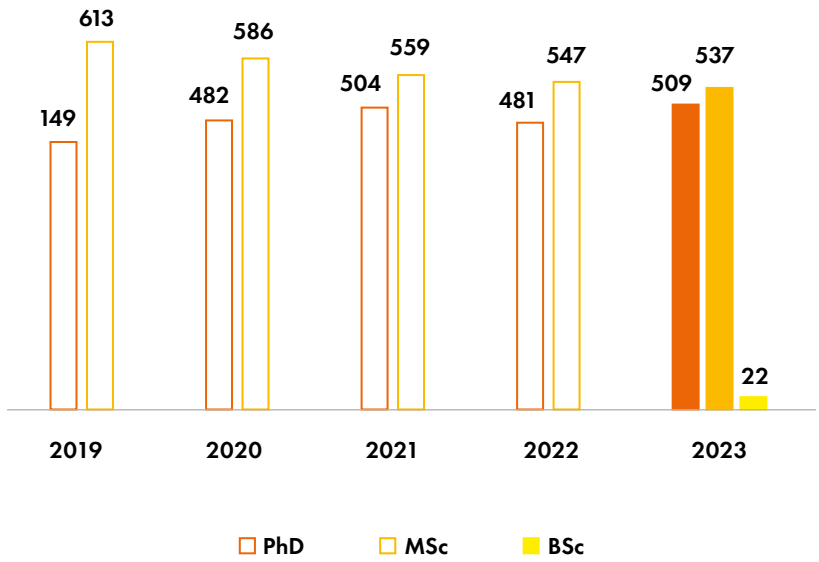
Personnel



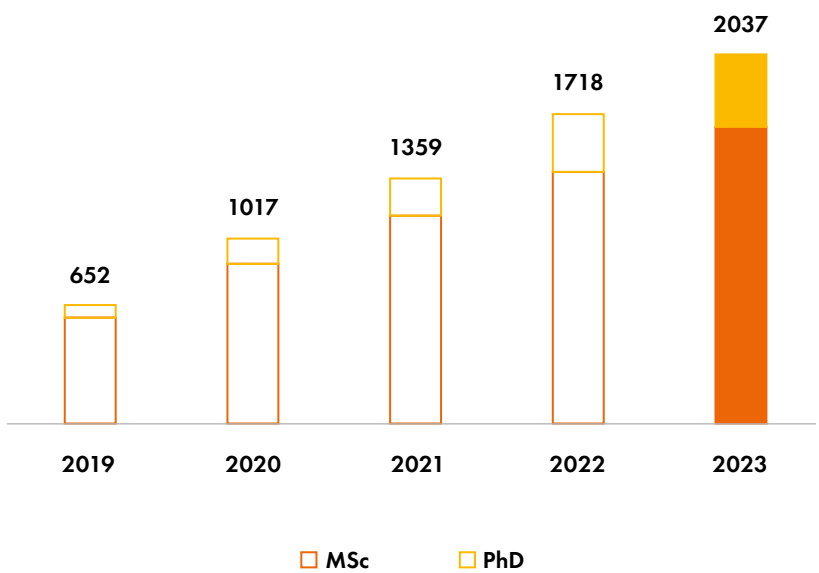
Faculty



Students by level of studies



Alumni (cumulative)



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Strategy report

Message from Senior Vice President for Development

Skoltech goal in 2023 was to resume a development path after challenges we faced.

The Institute is about people. We invested in human capital program resulted in new faculty appointments and decrease of staff turnover, we also improved a system of incentives and recognition. Not only retention, but also development of teams remain on the agenda for 2024.

Thanks to the taken measures, Skoltech continues to keep research and technology leadership. The Report 2023 highlights results, appraised with national and international awards. It also outlines results of the Centers – launch of new programs, development of technologies in the interests of the national economy and technology sovereignty.
We achieved results in education: this was successful outreach and recruitment, graduates' success. The launch of a pilot baccalaureate is also our significant step.

The Strategy was updated in October, becoming a foundation for a 'pyramid of goals' cascaded to all levels: Centers and laboratories, departments and functions, and each employee. These are important steps for our continuous development.

New opportunities and challenges are ahead. To face them, we should be creative, have a proper coordination of actions and ability to bear responsibility. We should be also capable to adapt, at the same time keeping a focus on long-term development and aspirations to be a 'choice number one' for students, staff and partners.

Alexander Safonov,
Senior Vice President for Development

KPIs

The strategic KPIs reflect the Strategy goals, targets of the Federal project 'Take-off: from startup to IPO', and the Grant agreement with Skolkovo Foundation. In 2023, the methodology for papers in prestigious journals was extended, allowing to account a wider list of journals (top 10% journals in subject categories of Scimago ranking).

Skoltech achieved all KPIs for 2023. Exceeding the KPI for graduates is explained by earlier admission numbers, while a growth in the number of startups was achieved due to student startups received grants from the Foundation for Innovation Advancement.

Strategic KPI	Unit	2023 plan	2023 result
Impact on the national economy	Bln Rub	23	24.7
Graduates (cumulative)	Persons	2010	2037
Graduates employed in the national R&D sector[4]	%	70	74
Skoltech associated startups in Skolkovo, and startups received support from institutes of development	Unit (cumulative)	110	118
Papers in prestigious journals and conferences	Unit	250	276

The KPI system also reflect operational targets. A slight deviation in graduates 2023 is explained by cohort flow indicators (e.g. academic leaves). The increase in external funding is reached by a growth of IP income.

Operational indicators	Unit	2023 plan	2023 result
Graduates (reporting year)	Persons	340±5%	319
New startups	Unit	20	26
Skoltech associated startups in Skolkovo	Unit (cumulative)	95	104
External funding	%	34	45

[4] Counted from the class in the reporting year.

Strategic initiatives

Advancing a reputation of a world leading research institute in six target domains

World class research

Centers' programs

Frontier research is a prerequisite for building strong capacities, development of cutting-edge technologies, delivery of educational programs, and presence in the global community.

Centers' programs are delivered in six target domains: Artificial Intelligence, Life Sciences and Agro, Advanced Materials and Engineering, Energy Efficiency and Energy Transition, Telecom, Photonics and Quantum Technologies, and Advanced Studies. In 2023 all programs were updated and presented to the Academic Council.

Programs' academic quality is reflected through different metrics, first of all, recognition. In 2023 16 faculty appeared in the list of top 2% world's scientists in Stanford ranking, considered as one of the most prestigious.

Artificial Intelligence


Prof. Evgeny Burnaev


Prof. Ivan Oseledets


Prof. Andrzej Cichocki


Prof. Alexander Shapeev


Prof. Dmitry Yarotsky

Life Sciences and Health


Prof. Mikhail Gelfand


Prof. Evgeny Nikolaev

Advanced Materials and Engineering


Prof. Artem Oganov


Prof. Alexander Safonov


Prof. Andrey Somov


Prof. Dzmitry Tsetserukou

Energy Efficiency and Energy Transition


Prof. Artem Abakumov


Prof. Alexander Kvashnin

Telecom, Photonics and Quantum Technologies


Prof. Vladimir Drachev


Prof. Albert Nasibulin

Advanced Studies


Prof. Anton Zabrodin

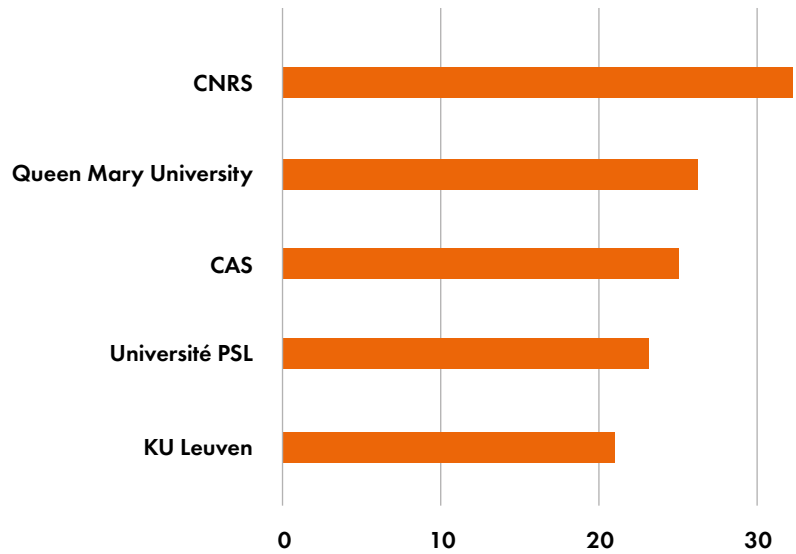
Publication activity is also a measure of quality. Skoltech published 240 papers in prestigious journals[5], while 36 papers were presented at the A* prestigious conferences.

International collaboration was in place: 60% of papers (top 10% SJR) were published with peers from international universities and research centers.

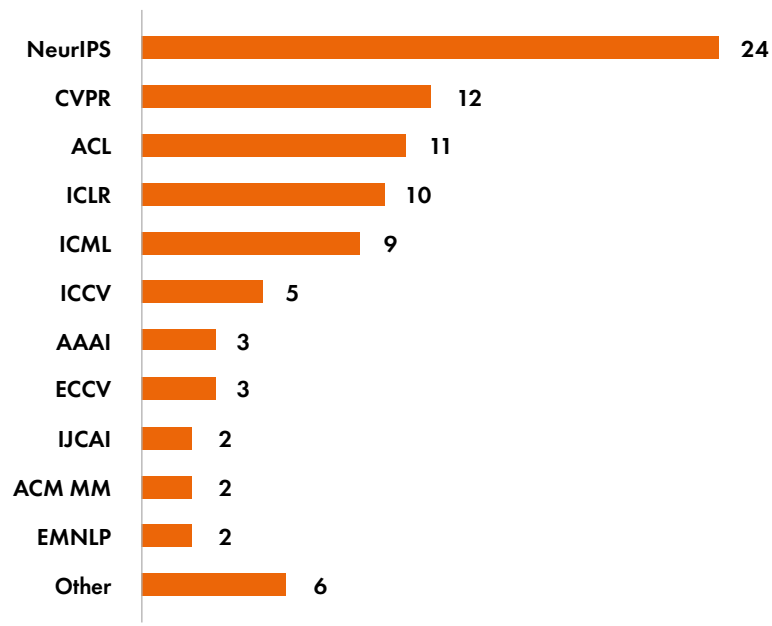
[5] Top 10% subject categories in Scimago ranking.

Publication activity

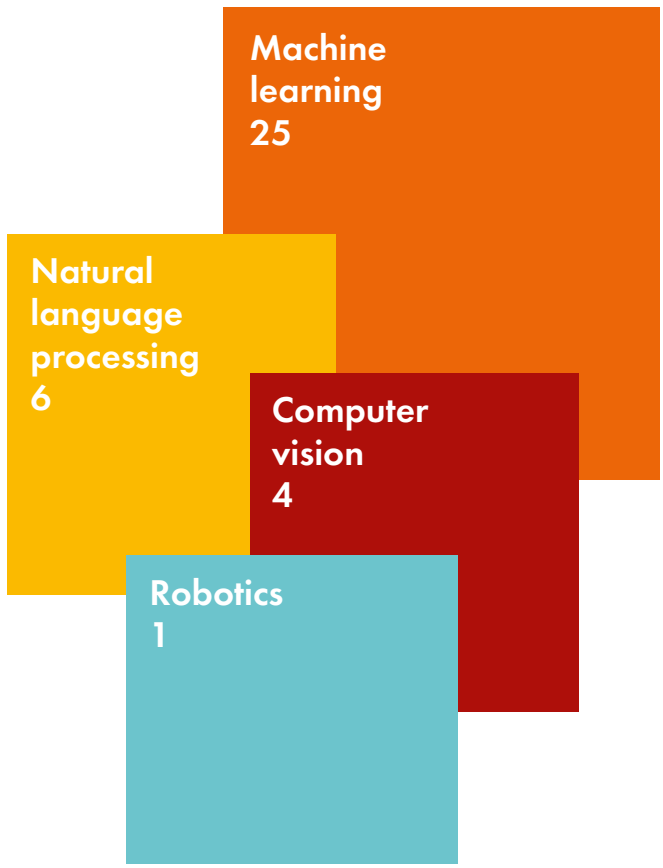
Key international partners (2023)



Papers in A* conferences (2021–2023)



Topics of publications at A* conferences (2023)



Strategic partnerships

International cooperation was advanced with the Middle East, India, and China.

The joint laboratory with Sharjah University (#1 in the UAE), was opened to pursue research in neurology, psychiatry, targeted oncology.
The Laboratory with Shanghai Institute of Optics and Mechanics was established to launch projects in Photonics.
Preliminary agreement was reached with Fudan University to set the Laboratory in Biophotonics. Projects in AI and Engineering were ongoing with Hamad Bin Khalifa University (a member of the Qatar Foundation for Education, Science and Social Development).

Skoltech partnership network was enriched with Khalifa University (UAE), Sharif University of Technology (Iran), Harbin Institute of Technology (China), Northwestern Polytechnical University (China), Indian Institute of Technology Bombay (India), Delhi University (India).

Visiting scholars program

The visiting program is ongoing from Skoltech foundation as a tool to maintain open academic environment and international standing. In 2023, scholars from Italy, India, China, and the United Kingdom were hosted by several Centers for research, teaching and research advising, and participation in seminars and conferences.
In 2024 the program will be expanded and promoted on the international market.

Internal grants

The program is ongoing to support initiative projects and start new collaborations.

The Clover program was launched with the MIPT and ITMO in the field of Photonics. The internal grant for collaboration with Sharjah University was expanded. Faculty startup packages were further funded (38 grants of ~ 105 mln. Rubles).

All grants are awarded on a competitive basis. In 2023, the total sum of new grants was ~ 36 mln Rubles.

External grants

The grant portfolio included 91 projects (1.3 bln Rub), mainly funded from the Russian Science Foundation.
The largest grants focused on establishment of new centers and laboratories in liquid hydrocarbon resources, neurorehabilitation, new materials, energy storage, turbulence, and coherent structures in integrated and non-integrated systems.

The notable result of the year was a grant for applied research in photonic integrated circuit production, awarded in the framework of strategic initiatives of the President of the Russian Federation.

Three-year megagrants were successfully completed:

- The Laboratory of Omics Technologies developed solutions that allow a high-precision measurement of protein concentrations to search for diagnostic biomarkers and personalize therapeutic approaches. Technologies were tested and implemented in several national medical centers.

- The Laboratory of Multiscale Neurodynamics for Intelligent Systems developed new methods for solving robust control problems in robotics, machine learning, computer vision, computational linguistics, and practical applications of petroleum industry.

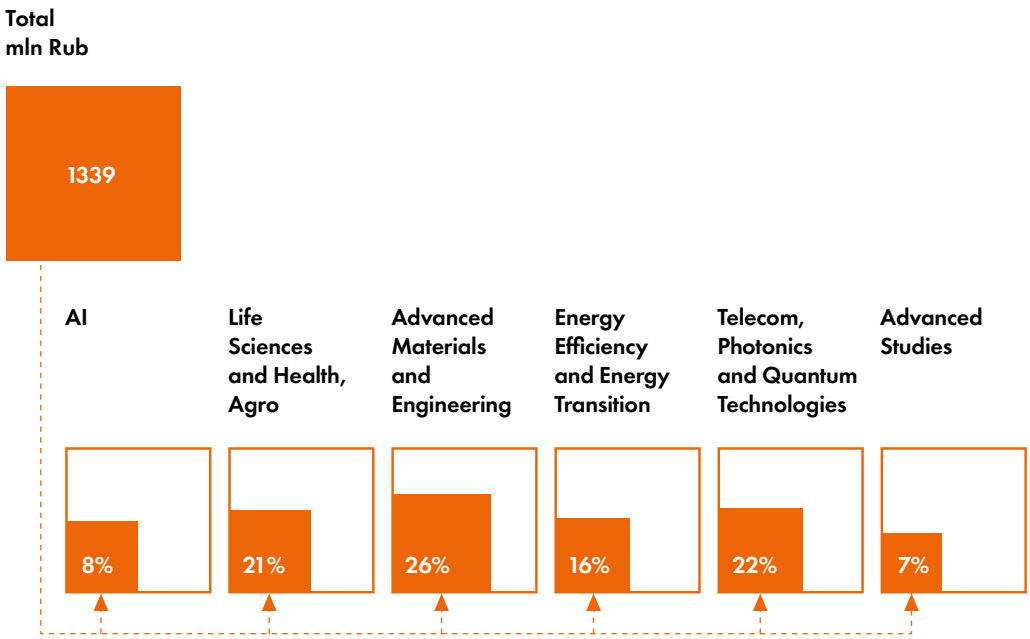
- The Laboratory of Modern Energy Systems was set to test solutions for traditional backbone and distribution networks, as well as micro-energy systems. Methods of monitoring, protection and management for future power systems were designed and verified using hardware and software modeling. The Laboratory continues R&D on topics important for electric power industry in Russia.

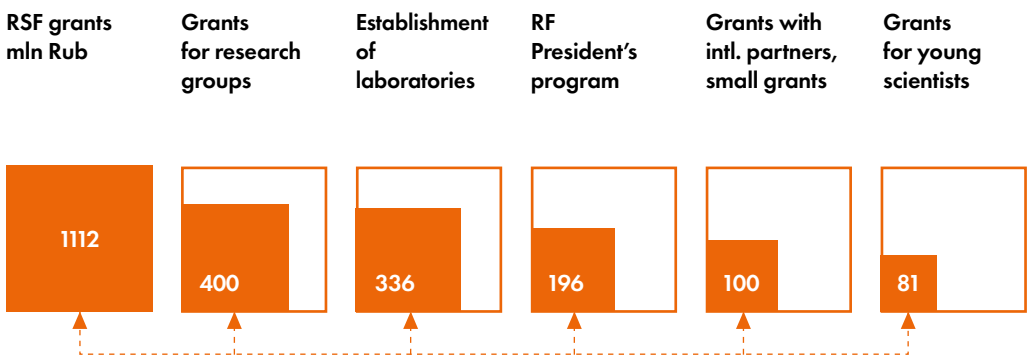
Skoltech academic degree

Skoltech launched the application of the right to autonomously award academic degrees of Doctor of Philosophy / Doctor of Science, expanding a PhD degree system, being in place since 2017.

Relevant policies were issued, 6 Expert Councils and the Attestation Board were formed. By the end of the year, out of five dissertations submitted, two were accepted for defenses, while the rest are under review. The first defense is planned in February 2024.

Grant portfolio (2023–2026)





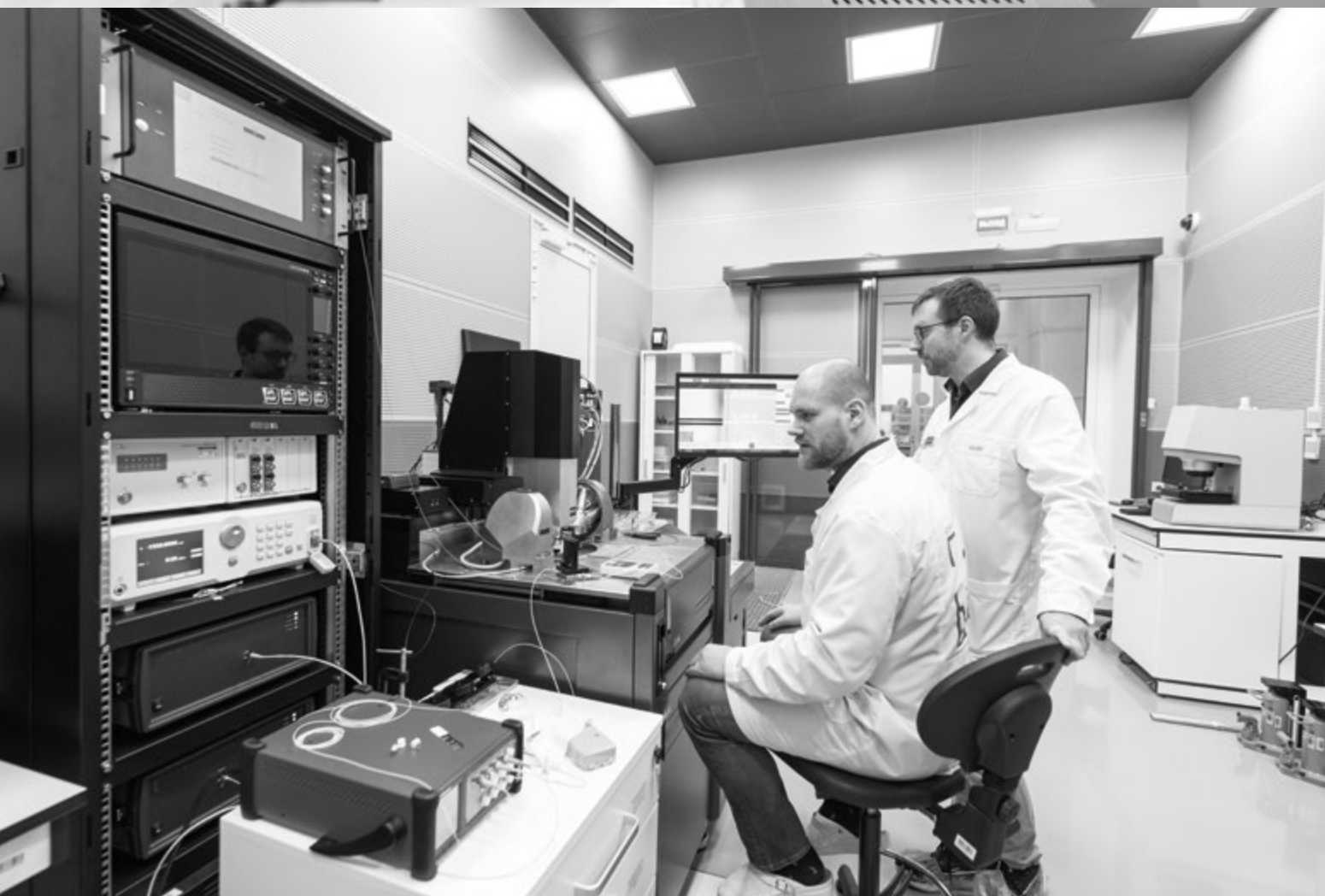
Research facilities

Advanced research facilities remain a primary goal. In last years, Skoltech significantly invested in laboratory infrastructure and recruiting top-level specialists. As of today, more than 90 labs are functioning, while new projects are launched.

With support of the Moscow Government, a unique facility for prototyping integrated photonics devices was launched (more than 30 units over 900 mln Rub). The facility will be used for contract production of integrated photonics devices, which will allow to have a stable and available tool for production of prototypes – starting from elements of telecom equipment and quantum distribution systems to medical products, LIDARs and fiber-optic sensor systems. Also, with support of the Moscow Government, equipment for domains of Materials, Engineering, and Life Sciences was purchased.

Within the newly established Laboratory with Shanghai Institute of Optics and Precision Mechanics, Skoltech contract manufacturing service for integrated photonics devices will be a tool for cooperation.

Seven centers of shared facilities (over 3,000 sq.m., and over 300 units) actively participate in RSF calls for hosting research projects. Since 2018, 28 projects (21 in 2023) were completed.



Research facilities

7.6 **bln Rub**	**equipment cost, incl. 1.1 bln Rub equipment under Moscow Government grants**
2309	**units**
26598 **sq. m.**	**research facilities**
52425 **sq. m.**	**planned research facilities**

Contribution to the economy through a key role in technology initiatives, programs with high tech companies

Technology development

Centers' technology programs

The programs are aligned with priorities of technology sovereignty and development of the national economy. All programs are developed in cooperation with governmental authorities and key industry players.

In 2023, the programs were updated accounting for new priorities, emerging areas, and involvement of Skoltech and associated startups in federal programs.

R&D programs

Skoltech participated in preparing proposals for the Concept of technology development of the Russian Federation. The proposals covered technology sovereignty based on own developments chains, functions of research institutes in technology policy.[6] Select proposals were included in the drafted Federal Law 'On technology pplicy in the Russian Federation'. Analytics on the concept of sky architecture[7] was prepared for the National Technology Initiative.

Jointly with federal authorities, companies, and universities, Skoltech acted as one of initiators and developers of following initiatives:

- Federal Project 'Advanced technologies for unmanned aircraft systems',
- Roadmap 'Advanced space systems and services' until 2030,
- Roadmap 'Modern and future mobile networks' until 2030,
- Roadmap 'Energy storage systems' until 2030,
- Roadmap 'Technologies of new materials and substances' for the period up to 2030.

The Program on technology development of the Arctic until 2035 was launched with universities, research institutions and companies. It includes over 130 proposals from more than 40 research and educational organizations, and the majority were supported by companies. In 2024, the Program will be promoted to the government level.

Skoltech is also presented in advisory bodies: examples include Committees of the Expert Council in technology areas ('Advanced Space systems and Services', 'Modern and future mobile networks', 'Artificial Intelligence', NTI Expert Council).

[6] 'Concept of Technological Development until 2030' was approved by the Decree of the Government of the Russian Federation dated May 20, 2023 No. 1315-r.
[7] The Federal Project 'Advanced technologies for unmanned aircraft systems' with technology intense direction 'Advanced space systems and services'.

Programs with industry

In implementing programs with industry, Skoltech targets a systematic approach serving as a 'one-window' for key partners. New clients are attracted to diversify a contract portfolio, reduce risks, and involve new teams in projects. The portfolio 2023 was composed of contracts with large national corporations and more than 30 medium-sized companies.

The other direction of activities is sharing analytics and reviews. The Energy Transition Center published quarterly reviews on trends in oil and gas, decarbonization markets and energy technologies.

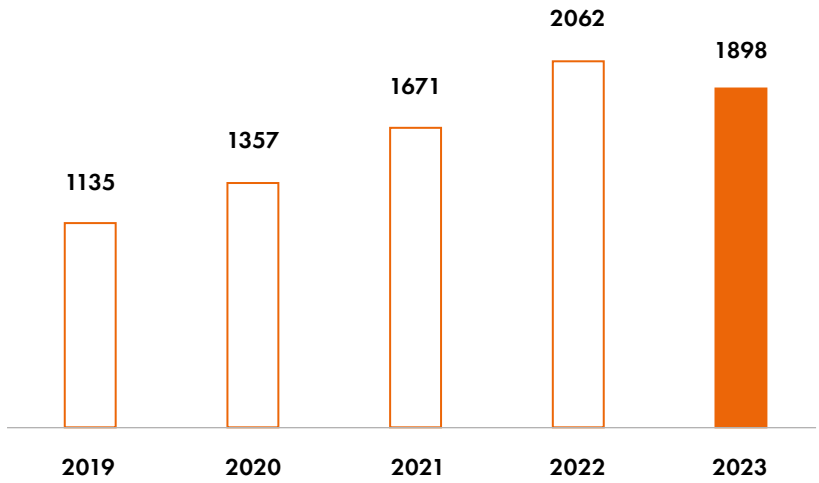
Cooperation with VEB.RF

As a member of the system of development institutes, Skoltech was involved in providing technological expertise within the project of VEB.RF business missions. This participation benefited to expansion of partnerships with regional research institutes and universities in such cities as Arkhangelsk, Chelyabinsk, Samara.

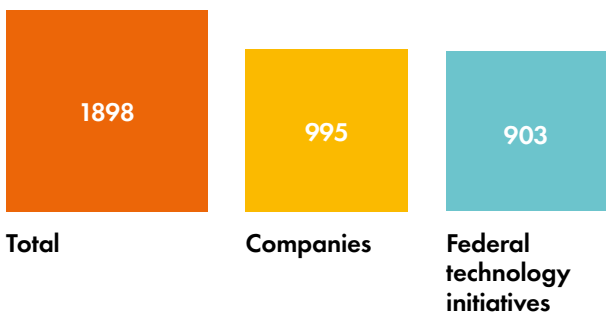
Cooperation within BRICS

In the framework of the Council of the Ministry of Science and Higher Education on Scientific, Technological and Innovative Cooperation of BRICS, Skoltech represented Russia in groups for Photonics and Biotechnology and Biomedicine, including Human Health and Neuroscience. The main results concerned defining topics for joint calls, forming R&D consortia, planning initiatives on technological sustainability of BRICS+ countries.

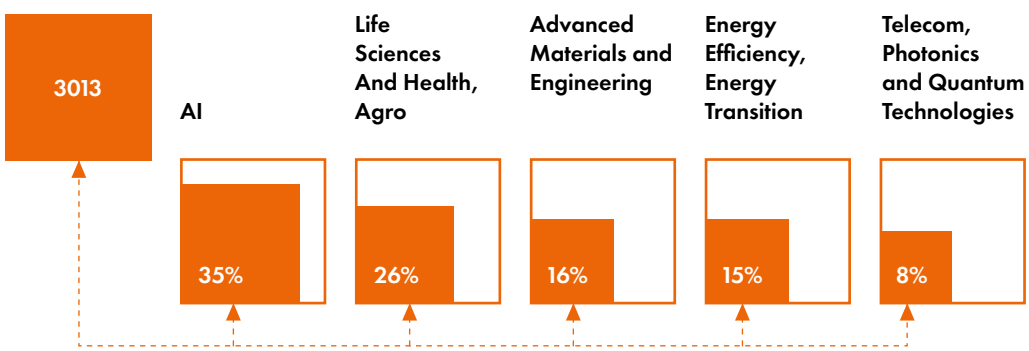
Annual R&D funding (mln Rub)



Structure of R&D funding 2023 (mln Rub)



R&D funding per domains 2023–2026 (mln Rub)



Centers' highlights

Artificial Intelligence

Applied AI Center
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Center for Artificial Intelligence Technology
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Life Sciences & Health, Agro

Center for Molecular and Cellular Biology
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Vladimir Zelman Center for Neurobiology and Brain Rehabilitation
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Project Center for Agro Technologies
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Advanced Materials and Engineering

Center for Digital Engineering
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Center for Materials Technologies
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Center for Petroleum Science and Engineering
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Energy Efficiency & Energy Transition

Center for Energy Science and Technology
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Project Center for Energy Transition
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Telecommu-nications, Photonics and Quantum Technologies

Center for Photonic Science and Engineering
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Center for Engineering Physics
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Project Center for Applied Photonics and Quantum Technologies
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Project Center for Next Generation Wireless and IoT
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Advanced Studies

Center for Advanced Studies named after I.M. Krichever
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Center for Research, Education, Innovation

Project Center

Center

Artificial Intelligence

Skoltech AI Domain is led by the Applied AI Center and the Center for AI Technologies. The Centers aim to create and develop cross-sectors algorithmic and software tools that allow to design application software for industry purpose.

The Centers focused on design of new AI algorithms for building generative models, consolidating multimodal spatiotemporal data, combining physical and machine learning models, reducing training time and power costs by compressing large neural networks and accelerating their learning, as well as other directions.

The AI algorithms are united into libraries and frameworks that can be added with necessary computing modules to create the AI software toolkit that allows scaling and applying industrial solutions, as well as creating a solid foundation for advanced research. The software toolkit – the corresponding basic computing modules – can be used for applied tasks and development of software for services, decision-making, for example in development of a territory or a company.

The Centers showed research excellence by publishing a large number of papers in A* conferences (36 in total, ICML, NeurIPS, ICLR etc.) and prestigious journals. The research results and technology solutions were transferred to Russian banks, oil and gas and telecom industry.

The Applied AI Center leads a large R&D program within the National Strategy for Development of AI in the Russian Federation until 2030.

Prof. Evgeny Burnaev

Director of the Applied AI Center, and the Center for Artificial Intelligence Technology

Applied AI Center

Conference paper among top 25% (ICRL conference (A*)

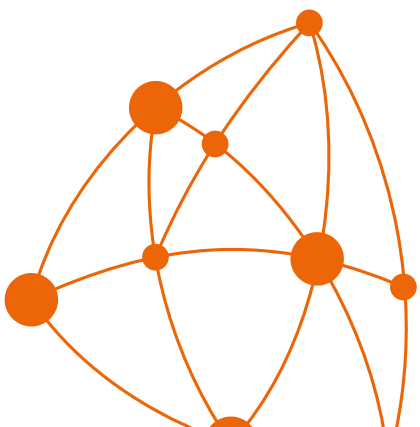
Evgeny Burnaev, Alexander Korotin, Daniil Selikhanovich and Ilya Trofimov took part in the ICLR conference in Kigali (Rwanda), which is one of the largest on fundamental machine learning and its applications in the world. The team's paper on a new Neural Optimal Transport algorithm for converting data from one domain to another using neural networks entered the conference top 25% list.

AI Laboratory with the University of Sharjah

Skoltech and the University of Sharjah established a joint AI Laboratory in Biomedical Research. The Laboratory will unite 36 researchers and focus on research of AI-based approaches: projects in psychiatry, neurodegenerative diseases, oncology, respiratory and metabolic disorders. The Laboratory will develop partnerships with top research institutes in Russia and the UAE.

SMILES-2023 Machine Learning School

The Machine Learning School 'SMILES-2023' was organized in Belokurikha Gornaya for young talented scholars interested in recent ML advancements and their application in complex engineering problems related to sustainable development. More than 700 applicants were received while only 65 talented scholars who completed a competitive selection, joined the school. More than 200 participants joined online. The participants could implement methods and algorithms in projects during the hackathon. All projects were completed on the base of Skoltech Zhores supercomputer.

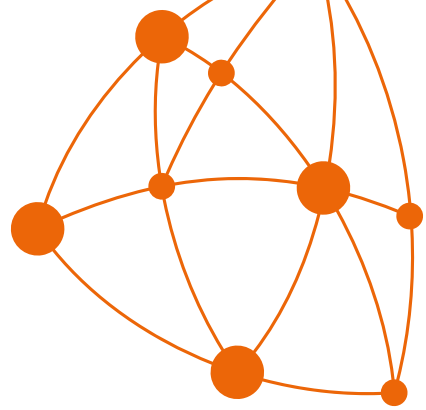


‘AI Leaders’ National Award

Alexander Korotin received the ‘AI Leaders’ national award for development of new algorithms that allow the use of generative models to solve complex applied problems. The research results are already being used to accelerate calculations and refine weather forecasts, necessary for predicting climate risks.

Yandex ML Prize

Nikita Gushchin received the Yandex ML Prize for the debut publication on development of new generative models based on solution of the Schrodinger bridge problem. Nikita’s research interests lie in development of new generative neural network for images and biological data. Currently the developed fundamental approach is being adapted to solve a problem of image resolution enhancement.



Center for Artificial Intelligence Technology

New neural network training framework

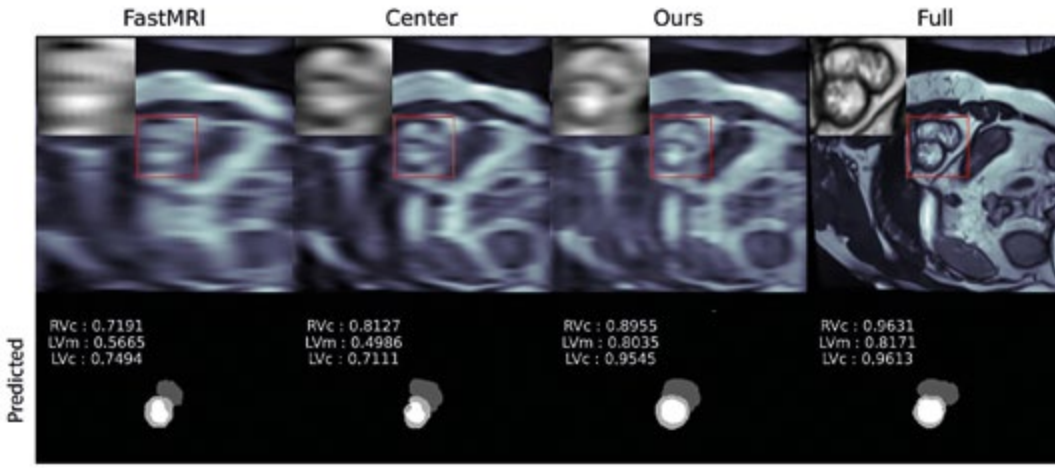
Alexander Mikhalev developed a new framework for training neural networks. Due to the usage of specialized parallel algorithms, it is possible to train GPT-type models with a size up to 4 times larger than when using standard tools of the PyTorch framework.

Natural Language Processing Laboratory (Alexander Panchenko)

The Laboratory main results of the year included:
(1) development of methods for constructing question-answering systems using knowledge graphs;
(2) development of methods for interlingual and multilingual text detoxification;
(3) development of methods for assessing uncertainty of language models.

Computational Intelligence Laboratory (Ivan Oseledets)

The Laboratory completed select work on development of machine learning methods for mathematical modeling, and development of tensor methods. A memory reduction method was developed for training neural network models by quantizing activations in the backward pass method (a FewBit method) – several papers were published at ICML 2023 and NIPS 2023 conferences. Patent applications were submitted for a universal Python package called 'Teneva', which is a broad set of tools for working with tensors in compressed formats.



Razumov, O. Rogov, D. Dylov, 'Optimal MRI Undersampling Patterns for Ultimate Benefit of Medical Vision Tasks,' Magn Reson Imaging, vol. 103, p. 37, 2023.

Computational Imaging Laboratory (Dmitry Dylov)

A new approach was developed to combine radiological scans with patients' data in the apparently first GPT-based image captioning model in medical imaging. The model was tested on popular datasets, all chest X-ray captioning tests were completed [1]. The extensive study of Image Quality Assessment metrics for MRI was completed, entailing 15,000 subjective reviews of the radiologists. Metrics, such as DISTS, HaarPSI, VSI and FIDVGG16 proved to be efficient across three major diagnostic criteria, accurately reflecting the perception of radiologists [2]. A method was found to accelerate acquisition of the MRI data by 16 times without a noticeable decrease in quality of subsequent image analysis [3]. The results were presented at the CMRxRecon Challenge (MICCAI 2023) and accepted for publishing.

AI & Supercomputing Laboratory (Sergey Rykovanov)

The Laboratory implemented a project with a large Russian bank resulted in speeding-up by 60 times the work of the ML-model automatic construction platform. The platform is used in the company to build various predictive models.

Prof. Mikhail Gelfand

Vice President for Biomedical Research, Director of the Center for Molecular and Cellular Biology

Life Sciences & Health, Agro

Center for Molecular and Cellular Biology

The Center conducts activities based on the assumption, that a strong fundamental research is a base for innovation and high-quality education. Despite certain challenges due to sanctions, the Center continues to maintain excellence. Moreover, Center's PhD students and young scientists have a key role in the most interesting research projects. In addition to publications in reputable journals, the Center's excellence is evidenced in the grant activity: almost each faculty and researcher, eligible for RSF grants, currently leads such grants as principle investigators.

Faculty continued to enrich the educational program with new courses and practical seminars, conduct outreach for a wider community. The course of Prof. Rybko 'Molecular Oncology for Medical Doctors' was in a high demand. Prof. Gelfand became a scientific adviser in the project 'Life and Other Stories' which is a series of interviews, where many faculty also took part.

The Center conducted a number of applied research projects. The Laboratory led by Prof. Nikolaev is developing a mass-spectrometer within the program funded by the Ministry of Science and Higher Education. The partnership program with Moscow Center for Innovative Technologies in Healthcare was ongoing, joint projects were held with the Moscow Government. Faculty were involved in several projects on finding new antibiotics and agricultural plants selection.

In 2023, the commissioning of laboratories in microbiological research was launched. This will allow to consolidate all laboratories of the Center on campus.

The Center also hosted the traditional 11th Moscow Conference on Computational Molecular Biology (MCCMB), which was attended by representatives of all top Russian bioinformatics research groups.

New approach in treating severe autoimmune disease

Ksenia Lupyr (a PhD student, a research adviser – Prof. Chudakov) became one of the key authors in the paper published in Nature Medicine. A fundamentally new approach for treating severe autoimmune disease, ankylosing spondylitis, was proposed. The authors identified protein motifs characteristic of autoimmune T-cell receptors and developed a method for a specific suppression of T-cells carrying such receptors. After testing on primates, the method was used to treat humans, proving its high efficiency. This therapy can be potentially applied to other spondyloarthropathies; its selectivity and a lack of systemic suppression of immunity opens opportunities for a new generation of safe and effective treatment options for autoimmune diseases.

Britanova OV, Lupyr KR, Staroverov DB, Shagina IA, Aleksandrov AA, Ustyugov YY, Somov DV, Klimenko A, Shostak NA, Zvyagin IV, Stepanov AV, Merzlyak EM, Davydov AN, Izraelson M, Egorov ES, Bogdanova EA, Vladimirova AK, Iakovlev PA, Fedorenko DA, Ivanov RA, Skvortsova VI, Lukyanov S, Chudakov DM. Targeted depletion of TRBV9+ T cells as immunotherapy in a patient with ankylosing spondylitis. Nat Med. 2023; 29(11): 2731-2736. doi: 10.1038/s41591-023-02613-z

Genetic code evolution

Prof. Gelfand and Michael Moldovan (a Skoltech graduate) with international peers for the first time discovered a variant of the genetic code, described the mechanism of reading such codons (a shift of the frame) and showed that despite expectations, these codons are not harmful and continue to be accumulated in the genomes of infusoria. This significantly changes existing ideas about molecular evolution, proving that fundamentally new properties of the main cellular processes (for example, translation) may appear during neutral evolutionary drift.

Gaydukova SA, Moldovan MA, Vallesi A, Heaphy SM, Atkins JF, Gelfand MS, Baranov PV. Nontriplet feature of genetic code in Euplotes ciliates is a result of neutral evolution. Proc Natl Acad Sci U S A. 2023; 120(22): e2221683120. doi: 10.1073/pnas.2221683120

Research of the Heracleum sosnowskyi genetic diversity

The research group led by Prof. Logacheva sequenced the genome of a dangerous invasive plant – Heracleum sosnowskyi. It turned out to have more than 55 thousand genes, although the majority of plants have 25-35 thousand genes. The reason behind lies in multiple duplications, especially of many gene families where there was a sharp increase in the number of genes related to the synthesis of secondary metabolites, including linear furanocoumarins (photosensitizing substances that give Heracleum its dangerous properties).
The study of the genetic diversity of Heracleum sosnowskyi and related species showed the absence of clear boundaries with two close species – invasive Western European Heracleum mantegazzianum and the endemic of the Crimea Heracleum pubescens. These data can be applied in development of the methods of the biological control and monitoring of this dangerous invasive species.

Prototype of a molecular test-system for precision measurement and quantitative analysis of blood proteins

The Laboratory led by Prof. Nikolaev developed a methodology of the quantitative analysis of blood proteins.
The first prototype of a molecular test-system for precision measurement and quantitative analysis of blood proteins was assembled. This system is on par with foreign commercial systems available on the market (the project is implemented with support of the megagrant).

Schelkunov MI, Shtratnikova VY, Klepikova AV, Makarenko MS, Omelchenko DO, Novikova LA, Obukhova EN, Bogdanov VP, Penin AA, Logacheva MD. The genome of the toxic invasive species Heracleum sosnowskyi carries an increased number of genes despite absence of recent whole-genome duplications. Plant Journal 2023 Oct 17. doi: 10.1111/tpj.16500 (WoS, Scopus Q1)

Best Professor Award

Prof. Khrameeva received 'Skoltech Best Professor' Award. She developed a new course 'Computational Biology of Aging', which is very popular among the students. The course content is unique as it forms a systematic view on the biology of aging and as well as offers a holistic computational methodology to study this problem.

Life Sciences & Health, Agro

Vladimir Zelman Center for Neurobiology and Brain Rehabilitation

The Center's primary goal is to become the leading neuroscience center in Russia. In pursuing this goal, the Center strives to be at the forefront of fundamental and applied research, developing and transferring advanced technology solutions to the medicine and healthcare, biotech and neurotech companies. Being at the fore ront of science and technology, the Center attracts talented scientists and students.

During the year the Center advanced the educational domain: a network BSc program and a professional training program in neuroscience were launched.

The Center conducts research in various areas of modern neuroscience, also in collaboration with international multidisciplinary teams. The research results continue to be at a high international level, as evidenced in the publication output: 4 papers (2023) were published in Nature and Nature Index journals, and about 15 papers in top 10% SJR journals.

Much attention is paid to implementing R&D results in healthcare, development of high-tech products and services. The Center collaborates with key infrastructural, medical, and clinical centers (e.g. Moscow Center for Healthcare Innovations, Federal Center of Brain Research and Neurotechnologies, Research Center of Neurology, Psychiatric Clinical Hospital No. 1, Samara State Medical University, Siberian State Medical University, Far Eastern Federal University) and high-tech companies. Projects for technology commercialization are in place – in 2023 2 startups were established with business partners and 2 startups set by the Center's students.

Neuro Center is committed to sharing scientific knowledge with the wider community: multiple lectures are held in Gorky Park, Yeltsin Center, VDNH, while interviews are given on the radio and TV.

Prof. Philipp Khaitovich

Director of the Vladimir Zelman Center for Neurobiology and Brain Rehabilitation

Approach for simultaneous treatment of phantom limb pain and restoration of somatic sensations

The Neurointerface Laboratory jointly with peers from the FEFU and the 'Motorica' company proposed the approach for simultaneous treatment of the phantom limb pain and restoration of somatic sensations using peripheral nerve stimulation. In the third and fourth stages of research for development of a technological package for relief of chronic phantom pains in the patients with amputation, the investigation concerned effects of electrical stimulation in participants with amputation of upper and lower limbs and a search for objective pain markers on an electroencephalogram. The research project is ongoing on the base of the FEFU Medical Center, and is supported with a RSF grant and 'Motorica' company. The results were published in the Brain Stimulation journal (IF>7.7, SJR= 2.18 (doi: 10.1016/j.brs.2023.04.017).

Testing of the methodology for risk assessment of mental illness has been completed

A two-year testing of the methodology for risk assessment of mental illness based on the lipid markers in blood plasma was successfully completed: samples of more than 1,500 diagnosed subjects from several regions of Russia and more than 1,000 volunteers were tested. The methodology accuracy exceeded 94%. The testing was the first stage of bringing the technology to the clinical practice. Commercialization of the technology will be made by a startup established. The methodology will be optimized until the end of 2025 in a partnership with clinical centers and Moscow Center for Healthcare Innovations. The methodology is a result of research conducted with international partners during 2016 – 2022. The results were published in JAMA Psychiatry (IF>25.9, SJR=6.58 (10.1001/jamapsychiatry.2022.4350), also a patent application was submitted.

Technology for applying biopolymer coatings to titanium endoprostheses

Based on the results of successful clinical testing of the biopolymer coatings with antibacterial properties based on PLACE[8] technology developed by Biomaterials Laboratory for a hip arthroplasty, the agreement was signed with NTI Competence Center 'Bionic Engineering in Healthcare' (Samara State Medical University). The agreement specifies a transfer of the technology of applying biopolymer coatings to titanium endoprostheses (joint implants) for a mass production of endoprostheses (implants). The PLACE technology is patented in Russia ('Production and use of films emitting medicinal products' No. 2807080 dd. 09.11.2023 (priority dd. 09.11.2022).

New startups

Four startups of the Center received a Skolkovo residency in 2023. The startups are focused on commercialization of the methodology for testing mental disorders, development and promotion of targeted delivery systems, a controlled release of drugs and excitation of neuronal activity based on nano-, micro-particles and containers, development of the AlterSense platform (rehabilitation using VR and electrical stimulation), and tools for automated measurement and training of olfactory sensitivity.

New educational programs

A joint network BSc program 'Cognitive Neuroscience' was launched with the Higher School of Economics.
The portfolio of professional training programs was added with 'Application of Machine Learning Tools for Healthcare Tasks' program, successfully implemented for faculty of the Advanced Engineering School of Samara State Medical University.

[8] Printed layered adjustable cargo encapsulation – printed, layered, customizable payload encapsulation.

Prof. Laurent Gentzbittel

Director of the Project Center for Agro Technologies

Life Sciences & Health, Agro

Project Center for Agro Technologies

The Agro Center plays a key role in development of Russian agro industry, contributing to creating opportunities across all sectors of the agro-food value chain. The Center conducts research and develops technologies in the following sectors: agro-supplies, agro-production, and agro-transformation.

Jointly with industry and private partners, the Center continues to shape the education system to accelerate a growth of Russian agroindustry. In 2023, the agreement was signed with the National Union of Plant Breeders and Seed Producers. Recommendations on training specialists for agro sector were presented to the Council of Federation. Jointly with partners, the Training Center of Plant Biotechnologies established on the base of the Center, successfully trained over 1000 experts during 2020 – 2023.

Jointly with international peers, several papers were published on envirotyping. The results were achieved in development of tools to accelerate and increase efficiency of genetic improvement of various agricultural species. Successful research was completed and papers published on the topics of wheat, barley, lupins, sunflowers, Luzerne, and dairy cattle.

The year highlight is the establishment of four startups in Skolkovo, some startups received support from Foundation of Innovation Advancement. Applying technologies of computer vision, deep learning, and biotech, the startups offer solutions on a value chain, including feed production, post-harvest monitoring, and field-level production prediction.

The results of the Center were possible due to dedicated efforts of a talented team of both young and experienced scholars.

Results in Envirotyping

The direction of Envirotyping covers several approaches, including modeling, which is based on data processing and process analysis. One of the factors which is significantly influencing agricultural processes, is water availability. In many cases, rainfalls serve as the main water source for crops, and their variability in volume and spatial distribution impacts agricultural productivity. Exploring new techniques to create digital twins of agricultural ecosystems includes modeling water volume and dynamics in soil. Another crucial aspect for agriculture, especially in the animal rearing, is availability of high-quality water, considering a prevalence of harmful algal blooms (HABs) in the fresh water. Environmental conditions play a major role in determining the onset and spread of the HABs. Skoltech developed machine learning techniques to predict HABs before their onset. Partnerships were set with top scientists in Russia and other countries, including the USA and India. Results were published in reputable sources (Water, Journal of Hydrology).

Forecasting methods of wheat development, yield, and quality

Based on the multi-year evaluations of conditions in the Southern Siberia and Northern Kazakhstan, the molecular tools became a key method for forecasting wheat development, yield, and quality. The research was ongoing with 10 research institutes in Russia and Kazakhstan, International Maize and Wheat Improvement Center (CYMMIT), and a number of companies. The results show a 3-4% improved yield due to the marker selection: this allows to significantly save time and costs. Also, the significant improvement in disease resistance is reported due to possibility to use a correct combination of disease resistance genes in a few generations. The study recommends a simultaneous validation and use of selected markers. The results were published in the Genes journal.

Technology solutions for cultivation of Lupin in Russia

The Center and peers from the Russian Institute of Radiology and Agroecology in Obninsk and Russian Lupine Scientific Research Institute offered several solutions to overcome a major issue in cultivation of Lupin in Russia – anthracnosis disease. By using the multi-omics integrated approaches which combine metabolomics, proteomics and transcriptomic, the metabolic pathways and candidate genes for susceptibility were identified. Novel biotechnological methods were developed to allow for genome sequencing in lupin, such as the additional module for biolistic apparatus. The protocol for accelerated selection to obtain a new sort of the white lupine was developed (the project is funded within the Federal Scientific and Technical Program for Development of Genetic Technologies for 2019 – 2027).

New startups

The agro-food value chain integrates various stakeholders. Several segments require innovation solutions to secure traceability, quality, and improve resilience. The Center's faculty and students established four startups, three of which became the residents of the Skolkovo and one startup received support from the Foundation for innovation Advancement. The startups focus on development of computer vision solutions for monitoring of the post-harvest decays of fruits or vegetables, production of eggs of hybrids of detrivorous fly larvae as a source of proteins or animal valued molecules, development of interactive solutions to predict yield and field rotations for 3-4 years; and development of the algorithm to use GIS and remote sensing images in agriculture.

Advancement of education

The PhD program 'Agro Biotechnologies and Engineering' was developed jointly with agro sector partners, while a MSc track for Agro Sciences was set in MSc program for Life Sciences. The Center presented target recommendations to the Council of Federation Council for improving the educational and training system in the agro sector. The project on establishment of the Training Center for Plant Biotechnologies, supported by a contract with the Bayer, was completed. Within the frame of this program, jointly with partners (Institute of Cytology and Genetics, Belgorod State Agricultural University, Timiryazev academy) 1000 scientists from research institutes, universities and agro companies received professional training. In continuation of the initiative, Skoltech will offer courses on 'Genome-based, data-driven plant breeding' on a fee basis.

Advanced Materials and Engineering

Center for Digital Engineering

The Center continues to develop advanced engineering expertise, research and technology and educational competencies in the area of system engineering and product development, system modeling, robotics and space, combining advanced research and engineering applications in the interests of Russia and the world.

In 2023, the Center recovered a faculty cohort after the sanctions, also increasing a publication activity in reputable journals. The participation in technology projects targeting high TRL, was significantly expanded. The sponsored research funding increased due to new contracts and grants.

The Center also established new startups and received IP for select results.

The highlight achievements include a key competence in producing of metal honeycomb cores for aerospace industry, advancement of PLM technologies, reaching the TRL-5 level by the SkSP-1 platform based on results of Skoltech-B1 and Skoltech-B2 satellites. Also, the results included creation of complex multi-scale materials, e-sports activities and the HyperDog. AI platform for intelligent interaction with environment.

The Center successfully completed the project under the program 'Education of the Future', which includes development of the engineering prototype for training and research experiments on the microsatellites in the outer space. Summer internships for students and schoolchildren were organized. A pilot BSc program in Engineering Systems was developed with the Innopolis University.

Four Center's faculty received Excellence Awards for outstanding achievements in teaching, mentoring and research.

The Center actively promotes science to the wider community. Scientists showcase technology solutions at the key industry and science forums.

Prof. Tatyana Podladchikova

Director of the Center for Digital Engineering

Innovative method for producing large three-layer structures

The innovative method was developed to produce unique large-sized three-layer structures with a flat and 2nd order curvature surface with multiple end-to-end channels, designed for thermal regulation of space and special techniques operating under extreme thermal and mechanical loads, which have no analogues in the world. The startup was established for honeycomb panel production for aerospace industry – preliminary agreements with Russian and international companies were signed. The development was conducted by the project team led by the Chief Design Engineer Gennady Rudenskiy.

Predictive maintenance technologies in the railway industry

A digital twin and a prescriptive diagnoses system of technical conditions of 'Lastochka' electric train were developed for a key national company in the transport sector to implement predictive maintenance technologies in the railway industry. The project received the award within the nomination of the industry partner.

Universal satellite platform SkSP-2

A new universal satellite platform SkSP-2 was under development, which allows to install a wide range of payloads from various manufacturers on a small spacecraft. The work was performed within 'Skoltech-F' project, which includes design, manufacturing, in-orbit control and a launch of a Cubesat 3U+ type nanosatellite based on a new platform. The platform has a testing module for various types of electronic storage devices to study information distortion due to influence of space factors.

Best paper award at IEEE conference 'Energy Internet and Energy System Integration'

Ilya Kamyshev and Sahar Moghimyan (PhD students) supervised by Prof. Ouerdane, received the Best paper award at the IEEE conference 'Energy Internet and Energy System Integration' (China, Hangzhou). The paper presents a new approach to generation of synthetic datasets for non-intrusive load monitoring systems. The data generators proposed by the authors, are based on the physics-informed methods and are capable of modeling a potentially unlimited number of appliances and their signatures. This is an important step forward for non-intrusive load monitoring systems that will help to identify and remedy anomalous or irrational electrical power consumption in households and commercial buildings.

New results in the Physics of the Sun

The breakthrough result in the Physics of the Sun was achieved with international peers using physics-informed neural networks and Skoltech supercomputer 'Zhores' to estimate the magnetic field of the upper atmosphere of the Sun in time close to a real time, which is not accessible in direct observations. The results were published in the Nature Astronomy prestigious journal (IF 15.647).

Jarolim R., J. K. Thalmann, A. M. Veronig, T. Podladchikova (2023), Probing the solar coronal magnetic field with physics-informed neural networks, Nature Astronomy, https://doi.org/10.1038/s41550-023-02030-9.

Prof. Ivan Sergeichev

Director of the Center for Materials Technologies

Advanced Materials and Engineering

Center for Materials Technologies

The Center's mission is to transfer new materials and technologies to industrial applications in the areas of strategic development of the Russian Federation. The main goal is to become a leading international research and educational center in material technologies, attracting talented researchers and students.

The Center accumulates unique expertise ensuring a transition from fundamental research towards development and certification of materials, technologies and products. Three key directions are being developed: polymer composite materials, additive manufacturing and functional coatings. Research in these areas is ongoing under Federal Programs, industrials projects and grants.

In 2023, the Center significantly advanced in establishment of laboratories, accumulating research experience, and developing partnerships. More than 120 mln. rubles of external funding were attracted, while the total portfolio of contracts and grants is 195 mln. rubles. The Center published 67 papers, including 13 papers in Q1/D1 journals. Professional educational programs were delivered for Russian high-tech companies in the area of additive manufacturing and polymer composite materials. The Laboratory of Computational Engineering was launched in collaboration with Skoltech Physics Center and Petroleum Center.

The Center continued developing of international collaborations. The Center's expertise is presented at the UN Economic Commission for Europe within participation on development of new sections of the UN Model Regulations on transportation of dangerous goods.

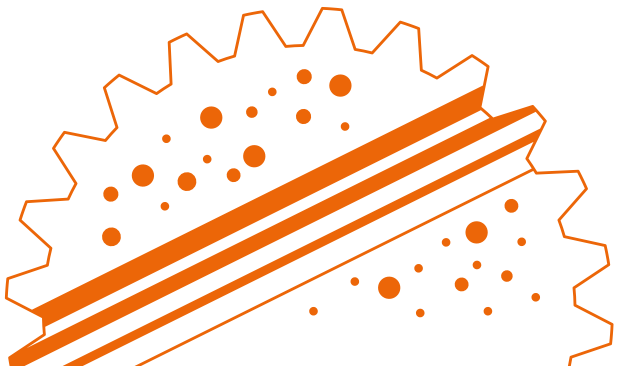
Functional coatings

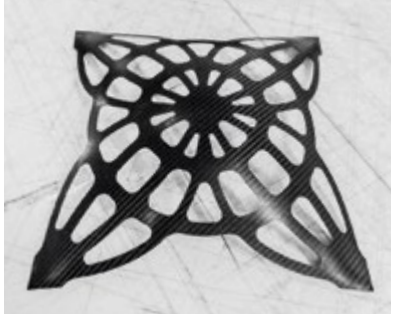
The anti-corrosion and anti-galling coating technologies were developed. The patented composition includes the inorganic silicate coating with a high proportion of zinc and the innovative additive to ensure a self-healing effect of coating defects during usage. The developed coating is used for protecting petrochemical storage, offshore platforms, bridge conduits and other metal structures operating in highly mineralized seawater, petrochemical synthesis products and those unprotected from ultraviolet irradiation of the solar spectrum.

The technology, developed in collaboration with leading metallurgical companies, ensures longer durability of drilling tools, reduced labor costs during field work, as well as a significant reduction in consumption of lubricants. Advantages also include the use of local components and materials, a simplicity of the method of application to a material made of carbon and stainless materials, control of the uniformity and thickness of coating, and possibility of implementation in the automated lines.

Laboratory of Computational Engineering

The Laboratory of Computational Engineering headed by Prof. Vasiliev was opened in collaboration with Skoltech Physics Center and Petroleum Center. The Laboratory conducts research in the area of multiscale computer modeling of physical systems and technological processes, develops new import-substituting and import-advanced technologies for computer modeling and virtual prototyping of physical and technological processes. The Laboratory distinctive feature is interdisciplinarity, which lies in development and unification of scientific approaches in the field of information technology, mathematical modeling, machine learning, high-performance parallel computing, mechanics, chemistry, physics, materials science, and engineering.





Shape memory composites

The experimental and theoretical research of the shape memory polymer composites were carried out with a Russian space company for manufacturing of structural elements of the solar panels of promising satellite systems; the project was conducted within goals to create a domestic satellite Internet. The technological solutions is used for creating solar panels and energy equipment for advanced satellite systems of the broadband Internet.

Anti-icing coatings

The anti-icing coatings were developed and a laboratory and full-scale test benches for the multirotor UAS[9] was set. The benches allows to study a process of ice formation on the propellers, measure their thrust and power output. The results will ensure the increase in duration of the UAS flight in subzero temperatures and wet conditions.

Technologies of additive manufacturing of ceramic rods of complex geometry

The Center developed the interdisciplinary research and a project on technology for additive manufacturing of ceramic rods of complex geometry for casting gas turbine engine blades. The project is conducted within the Federal Program 'Technologies of new materials and substances' and aimed at developing ceramic additive manufacturing technologies for manufacturing of turbine blade rods for aviation and gas turbine engines of a new generation. The improved ceramic rods of complex geometry are one of key components necessary for development of a new generation of the domestic gas turbine engines. The project includes the development of basic materials, a prototype of a commercial ceramic 3D printer, a multi-stage production methodology and manufacturing of a test series of ceramic rods for a full test cycle in an aviation company, including manufacturing and testing of turbine blades. The external funding for the project is 180 mln. rubles.

[9] Unmanned Aircraft Systems.

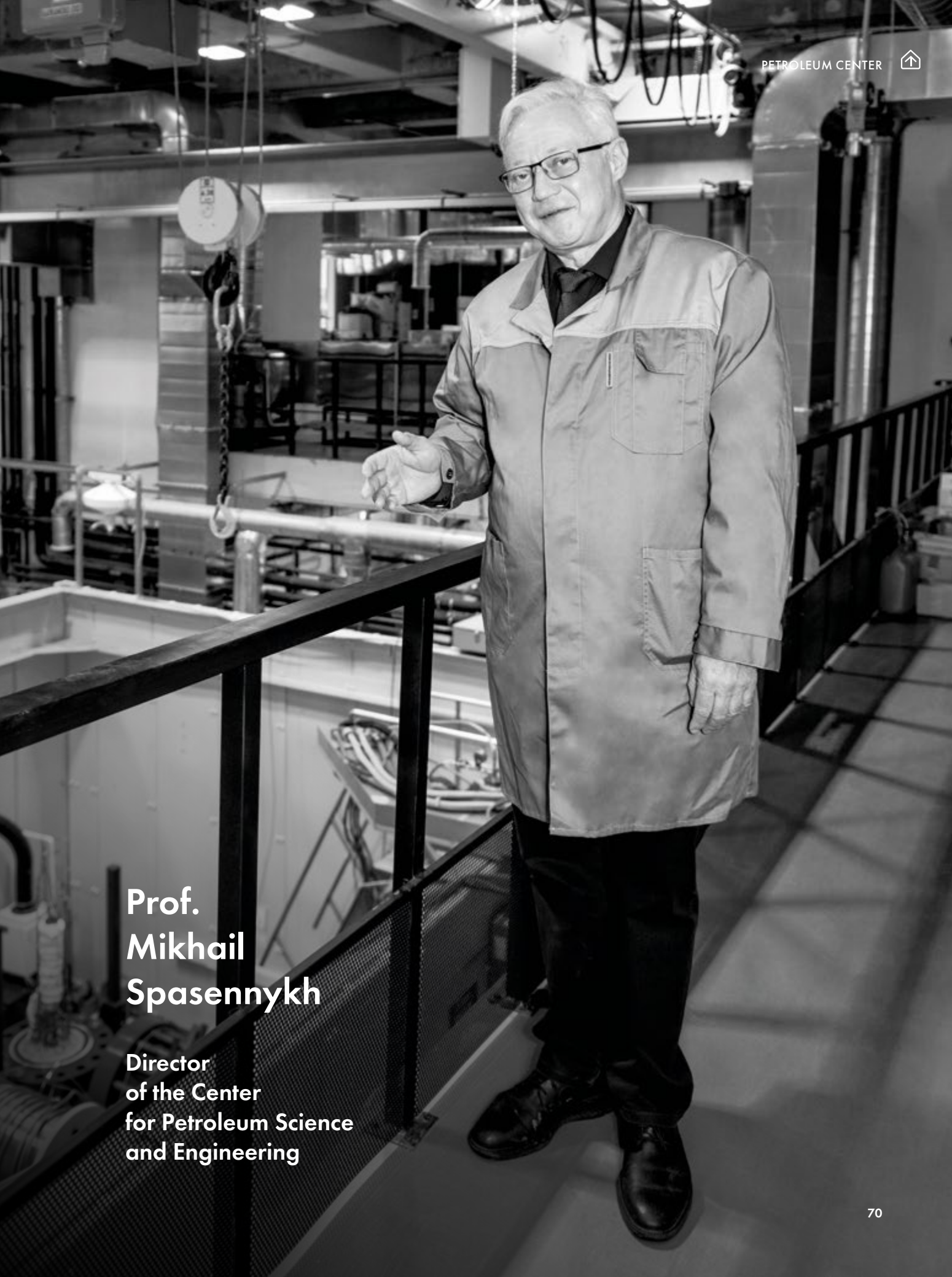
Advanced Materials and Engineering

Center for Petroleum Science and Engineering

The Center's strategy is focused on research, education, and innovation activities in the field of exploration and production of hard-to-recover and unconventional hydrocarbon resources. The following directions are prioritized:

- Unconventional and hard-to-recover reservoir characterization (petrophysics, geochemistry, geophysics, geothermics, digital core, and others)
- Geomechanics (experiment and mathematical modeling)
- Enhanced hydrocarbon recovery (gas, chemical, thermal, combined methods)
- Artificial Intelligence in oil and gas industry
- Modeling of formation processes
- Geocryology (permafrost and gas hydrates)
- New materials for petroleum industry
- Climate change, green energy.

The goals of 2023 included implementation of the research program, MSc and PhD programs 'Petroleum Engineering', development of professional programs for oil and gas companies, conducting work on the project 'World level center on rational development of hydrocarbon resources', as well as R&D and service works for companies of oil and gas and energy sectors.



Prof. Mikhail Spasennykh

Director of the Center for Petroleum Science and Engineering

World level center ‘Rational development of liquid hydrocarbon resources of the planet’

Intensification of production, enhanced oil recovery and development of hard-to-recover hydrocarbon reserves

The project ensures conduction of research and a significant share of Center’s technology developments. This project has been led by professors M.Spasennykh, A.Cheremisin, S.Stanchits, Y.Popov, D.Koroteev, D.Orlov, D.Eskin. The results include research and development in the areas of exploration and recovery of hydrocarbons in hardly accessible and underexploredterritories of Russia. The major results are: discovery of a new low-temperature hydrocarbon generation region in the southern part of the West Siberian Oil and Gas Basin. Also, the forecast of the prospects of the Khadum North Caucasus shale resources has been confirmed by field work and development of unique technological solutions for oil production using chemical, gas, and thermal methods. Hydraulic fracturing on pilot wells has provided stable oil production. The Center has published 27 papers, presented 60 conference papers, submitted 3 patent applications. The results have been included in the report reviewed by the RAS (Department of Earth Sciences).

The largest part of applied technology implementation results and the maximal share of revenue from contracts have been obtained in the field of intensification of production, enhanced oil recovery and management of hard-to-recover hydrocarbon reserves. The combination of experimental and mathematical modeling for development of the oil fields has led to appearance of new technological solutions for oil and gas production for the low permeable formations of the Western Siberia (Achimov and Tyumen Formations), carbonate reservoirs of the Eastern Siberia and Volga-Ural region, as well as other fields. The projects have been led by the professors: A.Cheremisin, C.Yuan, D.Eskin, D.Koroteev, D.Orlov, M.Spasennykh. The Center’s staff, PhD and MSc students have been involved in the project activities. More than 30 contracts over 220 mln. Rub have been completed. The Center has applied technology developments in the field of microanalysis, digital core, microfluidic studies of reservoir processes, multiphase hydrodynamic modeling, geochemical monitoring of production, as well as integrated development design (D.Koroteev, D.Orlov) accounting for technological and economic aspects of modeling, preparation and transport of hydrocarbons. The results have been used by companies and allowed to increase production and minimize costs. It is planned to conduct pilot tests of the technology of in-situ oil generation from solid organic matter of oil shales. The tests will be conducted in the Khanty-Mansi region jointly with a large industrial company, which is a key producer of pipes for oil and gas industry and Skoltech, and also with support of the RF Ministry of Energy. The results have been published in more than 30 papers in top-level journals. Patent applications have been also submitted.

Results in geomechanics

Within the partnership with oil and gas companies, the laboratory tests of hydraulic fracturing technologies, oil shales with various types of hydraulic fracturing fluids, including water-based fluids in a wide range of rheological properties, anhydrous hydraulic fracturing fluids based on diesel oil fraction, gas fracturing based on CO2 and other agents have been completed. The project, led by prof. S.Stanchits and senior engineer V.Stukachev, has been fulfilled by the Geomechanics Laboratory. The reports and recommendations on optimization of hydraulic fracturing regimes in oil shales have been submitted to the contractor and used in the company's operational activities. Several papers have been published in international journals, while reports have been presented at international conferences, and a PhD thesis on the corresponding theme has been successfully defended.

Strategic partnership with Rosatom

Within the strategic partnership with Rosatom in 2022 – 2023, the project continuing the work of 2019–2020 has been completed. The project focuses on the studies of properties of rocks and materials to justify a choice of sites and technologies for construction of an underground testing laboratory and a storage for disposal of radioactive wastes. The project is going on under supervision of professors M.Spasennykh and Yu.Popov involving Center's researchers and PhD students. The report for 2022-2023 has been prepared and defended, papers in top international journals have been published, a patent application has been submitted and a plan of activities for 2024-2025 defined.

New materials and technologies for oil and gas industry

The Center has conducted research and development on design of new materials and technologies for the oil and gas industry, extending the portfolio of high-value-added products made of hydrocarbon raw materials (including carbon materials). The materials and technologies for production of structures with embedded heaters which do not worsen mechanical properties, have been developed to address the problem of icing within the Arctic development program. Target technology solutions of non-autoclave molding have been developed for producing large-sized structures with 40x-100x multiple reduction in the energy consumption. The AI algorithms have been developed to monitor conditions of structures and detecting early destruction. The technology of utilizing carbon fibers for asphalt concrete production has been developed. Based on the results, 12 papers in top-level journals, incl. Nature Index, have been published and 2 patents received. The research has been done under supervision of Prof. S.Abaimov.

Prof. Artem Abakumov

Director of the Center for Energy Science and Technology

Energy Efficiency & Energy Transition

Center for Energy Science and Technology

The Center's strategic program is focused on fundamental research, design of new materials and technologies, and educational activities in the field of energy efficiency and energy storage to facilitate the Russia's transition to a low-carbon and carbon-free economy. The Center's program is organized around five thrusts: (1) Electrochemical Energy Storage, (2) Electrochemical Energy Conversion, (3) Smart Energy Grids: Systems and Devices, (4) Sustainable Low-Carbon Energy Systems, (5) Artificial Intelligence in Energy. The Center and its startups continue to play a key role in the roadmap for development of the high-tech area 'Electricity Storage Systems' up to 2030 (approved by the Government of the Russian Federation on 25.12.2023), being the key developers of modern cathode materials for lithium-ion batteries and technologies for their production.

The Center established a pilot production line of cathode materials with a capacity of 5-10 tons per year. The Center's activity in the field of post-lithium energy storage technologies is focused on sodium-ion and potassium-ion batteries, where a number of unique cathode materials have been developed, pilot production facilities for carbon anode materials were created and the prototypes of battery cells in a prismatic housing were assembled.

Thanks to collaboration with the National Technology Initiative, capacities of the battery cell prototyping line will be expanded up to 0.5 MWh/year.

The Center carries out research on the search of new electrocatalysts for hydrogen production and CO_2 conversion, development of stationary energy storage systems based on flow batteries, and creation of highly efficient photovoltaic cells based on perovskites. The Center created new hardware and software based methods for monitoring losses in the power grids, also developed power electronics elements for controlling energy distribution and storage systems.

Results in research for lithium-ion batteries

The complementary roles of cobalt and nickel in high-capacity cathode materials of lithium-ion batteries and promising ways of changing their chemical compositions were determined.

Biao Li, Zengqing Zhuo, Leiting Zhang, Antonella Iadecola, Xu Gao, Jinghua Guo, Wanli Yang, Anatolii V. Morozov, Artem M. Abakumov, Jean-Marie Tarascon, Decoupling the roles of Ni and Co in anionic redox activity of Li-rich NMC cathodes, Nature Materials, v. 22, pp. 1370–1379 (2023).

New patents

The patents were received for a new composite cathode material for lithium-ion batteries with high energy density and a method for its production, a new method for processing metal-ion battery materials, a new active composite electrode material for metal-ion batteries and ways of its production. These technological solutions allow to create lithium-ion batteries with high energy density and sodium-ion batteries that are affordable as for the raw materials and cost.

Abakumov A.M., Savina A.A., Orlova E.D., Skvortsova I., Additive to active cathode material for lithium-ion batteries, method of its production and active cathode composite material containing the additive, RU 2 791 251, 06.03.2023.

A.S. Samarin, A.V. Ivanov, S.S. Fedotov, Method of processing metal-ion battery materials based on vanadium and titanium compounds, RU 2 792 869 C1, 28.03.2023

A.S. Samarin, A.V. Ivanov, S.D. Schraer, S.S. Fedotov, Method for obtaining active electrode material and active composite electrode material for metal-ion batteries, active electrode material and active composite electrode material, electrode paste, electrode and metal-ion battery based on electrode material, RU 2 804 050 C1, 26.09.2023.

World-class Laboratory for development of advanced electrode components for energy storage systems

The World-class Laboratory for development of advanced electrode components for energy storage systems was established with a research team of 28 scientists. The Laboratory is established under the Agreement with the Russian Science Foundation No. 23-73-30003 dated April 13, 2023, total funding for 2023 – 2026 is 108 mln Rubles.

Prototype of an electrolyzer

A prototype of an electrolyzer for producing hydrogen with an anion exchange membrane with an anode material of its own design based on nickel and iron compounds has been developed.

Method for detecting commercial losses (theft) in power grids

A method for detecting commercial losses (theft) in power grids has been developed, which makes it possible to effectively use neural networks. The search for commercial losses is an urgent task of grid and power supply companies. The work was carried out under Megagrant, Agreement No. 075-10-2021-067 dated June 17, 2021 with the Ministry of Science and Higher Education of the Russian Federation.

Energy Efficiency & Energy Transition

Project Center for Energy Transition

In 2023, the Center strengthened positioning as leader in development of national technology for CO_2 capture and long-term storage in underground geological reservoirs. The Center also confirmed the expert role on the state-level projects.

The Center is represented by Center Director, Prof. Osiptsov in the working group under the State Commission on Mineral Reserves on developing a certification of the CO_2 storage, and the working group for import replacement in a technology chain of a medium-tonnage liquefied natural gas (LNG) plant (RF Ministry of Energy).

Detailed analytical reviews were presented on the import replacement in technological chain of LNG production, also a non-public research has been conducted for ensuring a stability of energy systems and sustainable industrial development accounting for new threats. The project on development of new technologies for oil and gas industry is ongoing focusing on reduced carbon footprint / negative impact on environment, optimization of gas production technologies at the gas condensate fields. The development is implemented accounting for energy transition that will primarily lead to decrease of oil and increase of gas in the Russia's energy balance.

Prof. Kvashnin, Head of the Computational Discovery Laboratory, entered a top 2% list of the most cited researchers in the world according to Elsevier journal.

Prof. Kvashnin is also a PI of the 'Computer Synthesis of Chemical Compounds' megagrant in G.A. Krestov Institute of Solution Chemistry RAS (implemented jointly with Skoltech), which positions Skoltech and its' core faculty as academic leaders in the Russian science.

Professional training programs on the topic of sustainable development of the energy sector of the Russian Federation were delivered by the Center's educational consulting and research unit; the programs were delivered for business and governmental representatives (large oil and gas companies, Ministry of Energy, Ministry of Foreign Affairs). The strategy session n innovation was organized for executive management of one of the largest oil and gas companies.

Prof. Andrey Osiptsov

Director of the Project Center for Energy Transition

Reviews and technology consulting (Head – Irina Gayda, MBA, Deputy Director of the Center)

The first 8-week open commercial executive program 'Sustainable Development of Energy Sector' was developed and delivered. More than 60 executive staff members of key Russian companies and banks joined the program (e.g. Ministry of Energy, Ministry of Economic Development, Ministry of Foreign Affairs, Accounts Chamber). Among the invited speakers there were Skoltech faculty, leading experts in climate, lawyers, representatives of large oil and gas and metallurgical companies. Positive feedback was shared by participants.

Development of technology for underground carbon storage for decarbonization of industry (Laboratory for Digital Modelling of Multiphase Systems, Head Prof. S.A. Boronin)

The Laboratory's research team jointly with a large oil and gas company continued the development of domestic CO_2 long-term storage technology in geological stratum. A numerical tool was proposed to assess geomechanical risks of CO_2 injection into an underground reservoir based on the mathematical modeling. A validation of the previously developed model of tectonic fault activation was carried out based on the published field experimental data on water injection into the fault zone. Correspondence was evidenced between results of calculations carried out within the framework of the model and experimental data for all key physical parameters. The new dynamic criteria for activation of a tectonic fault crossing a target reservoir for CO_2 placement was developed to predict potential earthquakes that occur during activation of tectonic faults and use seismic monitoring data on the surface to calibrate a mathematical model. A simulation of CO_2 injection into a depleted gas reservoir was carried out. The model is based on the field data obtained from the Center's industrial partner. Injection modes avoiding undesirable geomechanical risks were identified, leading to loss of tightness of the disposal zone. The results were published in 3 papers presented at Russian and international conferences, one paper is under peer-review at a Q1 journal. The design of the technology is being tested within two pilot projects for CO_2 disposal in the Orenburg region and Sakhalin.

Computational Discovery Laboratory (Head Prof. A.G. Kvashnin)

10 papers were published in top-tier journals (Nature Index, Q1 journals). A patent was received for producing powder based on a single-phase high-entropy carbide of the composition Ti-Zr-Nb-Hf-Ta-C with a cubic lattice. In the relevant publication in the Computational Materials (IF=12.25), computer modeling and AI methods were used to optimize a synthesis process of Ti-Zr-Nb-Hf-Ta-C carbide composition. Prof. Kvashnin entered a list of top 2% most cited researchers in the world.

MSc program 'Applied Computational Mechanics' (Director Prof. A.R. Kasimov)

A new program in applied computational mechanics was launched, offering eductation in advanced areas of theoretical and applied mechanics, applied mathematics, and high-performance computing. Graduates will be able to develop modern software packages for solving applied tasks in the high-tech industry. A pilot cohort of 6 students was enrolled, the program will be expanded in 2024. Considering the level of complexity, the program targets strong BSc graduates of Russian universities. For example, one of the students of the pilot cohost, Fedor Belolutsky, is a graduate of the Moscow Engineering Physics Institute, and is a winner of the II All-Russian Olympiad in Mathematical Modeling, organized by Rosatom.

Strategy session 'Redesign of approaches to innovation' for a large oil and gas company (Irina Gaida, Andrey Osiptsov)

The program was attended by 100 managers and young employees; the agenda included discussion of innovation management processes, new technologies, and a role of startups. Skoltech faculty (Energy Transition, Energy Science and Technology, Applied AI, Petroleum, Materials Technologies, and Agro) were involved in the program delivery. Executives management of the R&D dept of the largest state nuclear company were invited as external experts.

Prof. Alexey Frolov

Director of the Project Center for Next Generation Wireless and IoT

Telecommunications, Photonics and Quantum Technologies

Project Center for Next Generation Wireless and IoT

The Center was established to consolidate and strengthen world level competencies in the area of Wireless Technology and IoT, and to position Skoltech as the intellectual and technology leader in telecom and IT in Russia. In the last three years, the Center became a leader in development of end-to-end technologies in Russia, conducting research that addresses the national technological sovereignty.

The three-year project to develop the first prototype of a domestic 5G base station was successfully completed. The project was implemented by the Center with support of the NTI Foundation and RF Ministry of Digital Development, Communications and Mass Media. The technology was developed according to the international standards 3GPP and OpenRAN. The base station supports key services of 5G technology and is on par with modern foreign prototypes, the peak rate of mobile Internet reaches 1.4 gigabits per second in the frequency range 4.4–4.99 GHz (n79). The support for OpenRAN architecture standards allows a Skoltech solution to become the open platform, thus, the first domestically made 5G base station becomes the starting point for the country to establish its own telecommunications ecosystem. The technology was successfully commercialized as IP sales for a technological company.

In 2023, the Center was transformed. As a result of the successful implementation of the 5G project, the project team was transferred into a company to further ensure the technology scaling. The Center's research team will continue research and educational activities in the Center.

The Center implements MSc program 'Internet of Things & Wireless Technologies' which is the best one in telecom in Russia and one of the top in the world. Graduates are employed in leading telecom companies. In 2023, the Center developed and licensed BSc program 'Internet of Things & Wireless Technologies' (with ITMO University).

Growth of external funding

The Center raised 816 mln rubles of external funding, including the successful commercialization of IP for 5G technology, two new grants from the Russian Science Foundation for development of methods and algorithms for 6G networks (PI: Prof. Ivanov and Prof. Frolov).

BRICS Young Innovator Prize

Prof. Yudin proposed the approach for using high-speed cameras with shooting speeds of up to one million frames per second and neuromorphic sensors, also known as 'event cameras', followed by a post-processing to determine vibration parameters of objects in a generally contact-free manner. The RF patent No. 2022135480 'A system and method for non-contact measurement of vibration parameters of the surface of objects based on a neuromorphic camera' was received. The project received the BRICS Young Innovator Prize in the South Africa.

Partnership programs

The Center is expanding collaborations not only in Russia but also with international partners. Two MSc students of the King Mongkut's Institute of Technology Ladkrabang (Thailand) completed the research internship at the Center. The research seminar on blockchain was launched as a joint initiative with MIPT and HSE to unite Russian-speaking expert community in the relevant field. The seminar is led by Prof. Yanovich.

BSc program in Wireless Technologies

The Center developed and licensed the BSc program 'Internet of Things & Wireless Technologies' (with ITMO University). This will fasten and advance training of professionals in the field of telecommunications.

Publications in top journals and conferences

The research interns Butakov I.D. and Tolmachev A.D. (supervised by leading researcher Andreev K.V. and Prof. Frolov) prepared a publication on research of neural networks by methods of information theory, which was accepted at the ICLR 2024 (A*) conference. 4 papers authored by junior researcher and a PhD student Artemasov D.A. on study of 6G wireless networks are also worth noting, including a conference report at IEEE GLOBECOM. The report overviews the use of neural networks for decoding error-correcting codes in 5G/6G systems.

In total, the Center published 11 papers in Q1 journals and 5 papers at A/A* conferences.

Telecommunications, Photonics and Quantum Technologies

Center for Photonic Science and Engineering

In many ways, the year of 2023 was a year of acceptance and adaptation to the new reality for the Center. Facing a major change of situation, we thrived to find new ways to support each other, new academic partners to keep us at the cutting edge, new industrial partners to help us make our breakthrough a reality. While some of us left, new faculty joined the Center.

The past year saw us actively work to build new bridges to the East, with the launch of a joint laboratory with the Shanghai Institute of Optics and Fine Mechanics, a world leader in the field of integrated optics. Five teams of scientists from Russia and China are already hard at work solving some of tomorrow's critical problems in fields of AI-driven imaging, cold atoms, mass-spectroscopy and photonics integrated circuits for advanced applications. On the national level, we continued to develop ties with leading institutions, notably through the 'Clover' collaboration initiative with IMTO and MIPT, which in under a year has already yield impressive results.

We also rethought the approach to educational activities to better match the current needs and expectations of new student generations, by laying the first stones towards dedicated programs in quantum technology and applied photonics.

Last, but certainly not least, we have defied the odds by publishing numerous papers in prestigious journals, despite many new hurdles placed in our way. Driven by the strong bonds between our research groups and with other research centers, these publications are a testament of the vibrancy of our community.

Prof. Pavlos Lagoudakis

Vice President for Photonics, Director of the Center for Photonic Science and Engineering

Vyzov Award

Prof. Pavlos Lagoudakis and Prof. Sergey Alyatkin received the prestigious Vyzov award for their pioneering work in polariton-based computing. Organized for the first time by the Vyzov Fund in collaboration with Gazprombank and the Moscow City Government, the mission of the award is to engage young generations in science and technology in Russia.

Publications in prestigious international journals

The Center maintained a high-level publication output, with 10 Nature Index publications in topics ranging from fundamental studies of photonic material systems to demonstrations of advanced devices such as bolometers and liquid biopsy sensors. This included numerous publications in high impact and prestigious journals such as Science Advances, Materials Today Advances, Chemical Engineering Journal, Carbon and ACS Applied Materials & Interfaces.

Laboratory with Shanghai Institute of Optics and Fine Mechanics

A new Joint Laboratory in Photonics Sciences was established with the Shanghai Institute of Optics and Fine Mechanics of the Chinese Academy of Sciences, a global leader in the integrated optics. Uniting research efforts in fields of photonic integrated circuit technologies for communication, sensing, and computing, artificial intelligence in optical imaging and laser-plasma interactions and cold atomic physics in quantum computation and optical clocks, 5 collaborative projects were launched under the umbrella of the joint laboratory.

Startup of the Nanomaterials Laboratory

The startup was established by Prof. Nasibulin, Prof. Fedorov and PhD student V. Zaytsev of the Nanomaterials Laboratories. A culmination of several years of intensive R&D, the new startup is developing smart gas sensors, novel solutions for the analysis of smells, gases, and complex gas mixtures. Broad applications are planned within the manufacturing industry with contracts already in place with leading Russian and international companies.

Picosecond fibre laser

Prof. Gladush and colleagues from the Nanomaterials Laboratories developed a unique low-cost and high-performance picosecond fibre laser emitting at 920 nm. This laser, capable of substituting bulky and expensive titanium-sapphire sources in some applications, provides unique capacity to the Russian research landscape by providing a key tool for quantum optics and quantum computing. The first laser was delivered and will be used in projects central to the Quantum computing Roadmap.

Prof. Vladimir Drachev

Director of the Center for Engineering Physics

Telecommunications, Photonics and Quantum Technologies

Center for Engineering Physics

The Center's strategic goal is to develop new capabilities starting from development of fundamentals in physics to technologies aimed at clearly defined industrial demands. The Center focuses on the core areas: Superconducting Materials and Quantum Technologies, Plasmonics and Nanophotonics including integrated silicon photonics.

The specific goals include: (1) completion of development and demonstration of a prototype of the quantum current standard for the first time in the world in the next three years, (2) development of a (Si)-photonics technology, (3) development of components for next generation of wireless communications based on available integrated (Si) technology.

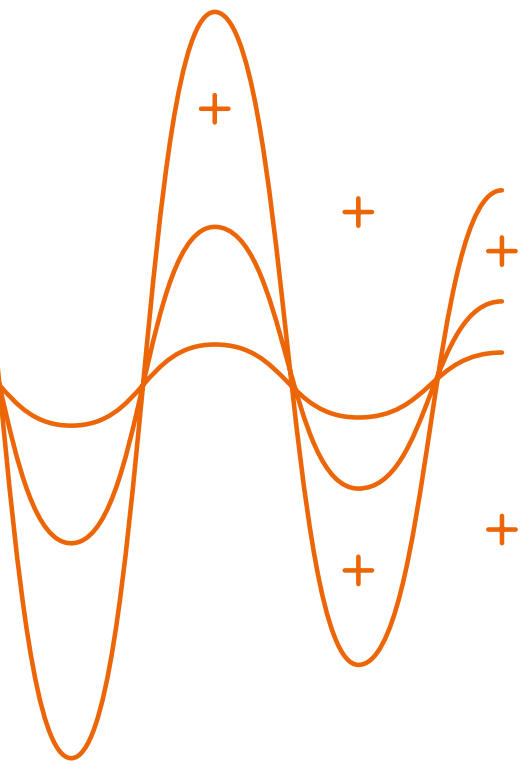
The Center's is a team of professionals, headed by 6 faculty and 3 leading research scientists. PhD and MSc students are involved in implementation of the strategic goals, actively participating in solving project tasks as research interns or engineers. Three of PhD students have prepared theses, the defense is scheduled for February – April 2024.

The 2023 results achieved by joint efforts of the Center's associates include both, breakthrough achievements in research, supported by more than 20 publications in Nature Index and top journals (SJR 10%), and their applications to solve specific practical tasks set by partners.

The Center's research credentials are confirmed by RSF grants as well as proposals for cooperation from the industry. Faculty and researchers actively participated in preparation and submission of applications for project competitions organized by external organizations (RSF projects: Leading research scientist O.A. Lychkovsky, Prof. Drachev); Prof. V.N. Antonov and Prof. S.S. Kosolobov applied for external competitions and Skoltech projects. Active participation in calls allowed not only to exceed KPI for external funding, but, also laid a foundation for future collaborations.

Development of a micro-spectrometer for optical fiber sensors based on integrated (Si) photonics technology

The researchers of the Plasmonics Laboratory continued developing a compact signal analyzer for fiber-optic sensors KASVOD within the framework of cooperation of a Competence Center for Photonics of the Scientific and Technological Initiative.



Development and demonstration of the first prototype of quantum current standard

The Russian-Chinese project, supported by the Russian Science Foundation and a foreign National Science Foundation, has been successfully completed. The project has strengthened the international academic partnerships. The main results include:

- the quantum regime of a phonon crystal on surface acoustic waves is demonstrated and studied;
- a flux qubit with a pi-contact is implemented;
- the qubit is implemented in the RF SQUID geometry with a high-quality wire on an ultrafine aluminum film.

These results are presented in 8 publications, 7 of which in Q1 (Phys. Rev. Lett., Appl. Phys. Lett., Phys. Rev.A, etc.). In addition, current quantization in Josephson junctions under the action of microwave radiation was experimentally demonstrated in 2023. This effect can form the basis for the creation of a quantum metrological current standard. The work is currently under review in Nature Physics.

Development of components of next generation of wireless communications based on available integrated (Si) technology

In 2023 the Theoretical Nanophotonics team continued a successful development and application of highly efficient methods for calculating resonant photonics systems. As part of the RSF project, results on the formation of high-quality resonances in moire structures were obtained for the first time. The use of the resonance approximation method makes it possible to significantly optimize calculations and increase not only the speed of calculations, but also the level of understanding of the fundamental physical processes underlying the functioning of photonic systems. Based on the results, successful research is conducted on one of the key tasks of silicon photonics – to increase the efficiency of light emission by silicon nanostructures by creating an optimal resonant photonic system. The obtained research results have been published in leading international publications.

Educational program

The Center continued advancement of Photonics program with new courses: 'Technical Physics', 'Introduction to Solid State Physics', 'Nanooptics', 'Fundamentals of Photonics', 'Quantum mechanics'. Jointly with the Photonics Center, the MSc program 'Photonics and Optical Technology' has been developed (launch in 2024).

As part of a collaboration on the Clover project, Prof. S.A. Dyakov with Prof. Yu.G.Gladush (Photonics Center) organized the conference 'Resonant nanophotonics educational workshop' in order to attract talented students and introduce modern trends in photonics. 25 reports were presented at the conference. In addition, a workshop on the Comsol package was held for students. The total number of participants was 100 people. Several researchers and PhD students received awards for participation in programs and promotion of innovation in the educational process.

International collaborations

In addition to collaboration on a faculty peer-to-peer level, international cooperation was supported through the grants. Prof. Oleg Astafyev led the project supported by the Russian Science Foundation and the foreign National Science Foundation, where the Russian side is represented by Laboratory of Superconducting Quantum Technologies, and the foreign side includes several leading universities. The project is aimed at studying the physical foundations of new promising approaches to quantum systems based on superconducting technologies. The project resulted in a Russian-Chinese symposium: '2023 international workshop on quantum information', Zhangjiajie, China, July 4-8.

Outreach activities

The Center took part in a number of professional events, and also promoted Skoltech brand. The Center organized and held the All-Russian conference 'Superconductivity in Nanostructures 2023' attended by over 150 participants – both, leading Russian scientists in the field of superconductivity of nanostructures as well as young scientists, students, postgraduates and laboratory researchers of Russian research centers. The conference helped to enhance the role of Skoltech as a key center in development of this field, the foundations of which were laid by the leading Soviet physical schools.

Telecommunications, Photonics and Quantum Technologies

Project Center for Applied Photonics and Quantum Technologies

The Center is focused on research and development to satisfy the needs of Russian industry in such areas as telecommunications, space and aircraft engineering, and instrumentation. The main technological focus of the Center is:

- integrated photonic technologies;
- photonic integrated circuits (PIC);
- system studies of problems of time and frequency, satellite navigation;
- photonics for space applications;
- 5G Advanced/ 6G wireless communication.

Since its launch in 2023 the Center made it its mission to develop competencies and apply them in highly innovative and science intensive engineering research projects with relatively high technology readiness level (TRL). All the main technologies are developed in the so-called technological 'death valley' of TRL 4-7, where the transition from fundamental research to application, aimed at creating fully functional prototypes begins.

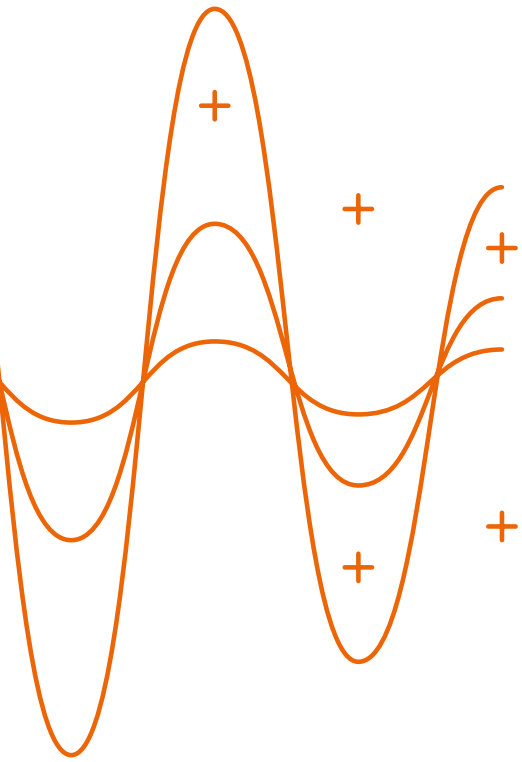
The Center conducts applied research for state corporations, large and medium-sized technological companies as well as national programs for the development of target hi-tech areas. A full cycle of development, testing, pilot production and prototyping of PIC is being created to account for the developing global PIC industry that is completing modern microelectronics.

The Center carries innovation activity. Center's young researchers are gaining technological entrepreneurship skills, working in real commercial projects and developing their own directions. Every year we develop so-called spin-offs, bringing university technology to a high TRL level to ensure commercialization of the results.

International collaboration is ongoing: agreements are made and joint efforts are held with a number of Chinese universities; research is conducted in photonics under the relevant BRICS working group. Applied work is implemented with international companies.

Prof. Pavel Dorozhkin

Director of the Project Center for Applied Photonics and Quantum Technologies



Design Center for Photonic Integrated Circuits

Development, production (at outsource companies) and testing of the PIC have been established. The standards of available serial fab plants have been mastered, development chains, testing and refinement of PIC chips have been established. The first working prototypes have been obtained – for applications in telecommunications, sensors, and quantum communications. The first library of passive PIC components in Russia – as one of the stages of creating a fully functional fab plant in Russia.

Quantum sensors and calculations, navigation

Successful work was conducted for 'Russian Space Systems' company to create technologies for compact optical frequency standards with PIC elements in order to develop domestic precision navigation systems. The first Russian planar ion trap based on PIC technologies has been created for use in the developed systems of quantum sensors and quantum computing on single ions.

Support of government technology development programs

The preparation and examination of state program documents (roadmaps) for the development of high-tech areas of wireless communications (5GAdvanced/6G) and space technologies was carried out in collaboration with partners. Program implementation is planned for 2024. Russian PIC development and production chain is being developed with working groups of the Ministry of Industry and Trade, the Moscow Photonics Cluster, and the Russian Academy of Sciences. The Center actively participates in working groups of the National Technology Initiative, the Ministry of Finance and the Scientific Council of the Russian Academy of Sciences on the development of wireless communications.

Educational activity

The foundation of a new educational program in applied photonics have been laid: a new course on modern photonic devices and their applications has been developed and introduced into the curriculum, courses on telecommunications have been finalized, and new courses in engineering are being developed. Existing joint applied MSc programs with leading Russian technological universities are implemented and new ones are under development.

Innovation achievements

Requirements specification for major infrastructure projects in the field of photonics and navigation in the interests of the space industry have been reviewed and formally approved — start in February 2024.

The team of graduate students of the Center and employees of the Skoltech spin-off company (development of photonic integrated circuits) received the main prize among more than three dozen participants at the 'battle of pitches' held by 'Saint Petersburg' energy hub for a large Russian petroleum company. Further work is underway to implement the proposed solutions for monitoring the condition of pipelines and preventing emergencies.

Prof. Andrey Marshakov

Director of the Center for Advanced Studies named after I.M. Krichever

Advanced Studies

Center for Advanced Studies named after I.M. Krichever

In the beginning of 2023 the Center for Advanced Studies has been named after its founder I.M. Krichever. The Center continued cutting edge research in the main areas, including geometric representation theory, string theory and two – dimensional conformal field theory, integrable systems, combinatorics and singularity theory, symplectic geometry and topological recursion, statistical physics.

The results of research are reflected in more than 70 scientific publications (more than 85 with the Laboratory of Integrable Systems and Turbulence), including more than 40 published papers.

The most notable are achievements in the field of homological algebra, combinatorics, integrable systems, topological recursion and two – dimensional quantum gravity.

In 2023, the Center resumed the spring research schools in Mathematical Physics, attracting the strongest students from all over the country, and organized the international conference 'Geometry and Integrability'.

The scientific paper on minimum gravity

The scientific paper of the youngest researcher of the Center (and a PhD student – scientific supervisor A. Litvinov) A. Artemev on minimum gravity. A. Artemev published 2 papers on this work in JHEP (Nature Index journal) and supervised the work of a PhD seminar in this area

= = A. Artemev, 'p → ∞ limit of tachyon correlators in (2,2p+1) minimal Liouville gravity from classical Liouville theory', J. High Energ. Phys. 2023, 155 (2023), doi.org/10.1007/JHEP12(2023)155

= = A. Artemev, V. Belavin, 'Torus one-point correlation numbers in minimal Liouville gravity', J. High Energ. Phys. 2023, 116 (2023), doi.org/10.1007/JHEP02(2023)116

International 'Frontiers of Science Award'

The International 'Frontiers of Science Award' of the International Congress of Fundamental Science in Beijing was awarded to Prof. M. Finkelberg (with A. Braverman and H. Nakajima) in the nominations 'Homological Algebra, K-theory and Noncommutative Algebra' and 'Mathematics of String Theory and Condensed Matter'.

Successful development of educational process

5 new courses –
= Representations of Finite Groups,
= Cluster Varieties and Integrable Systems,
= Phase Transitions, Rigorous,
= Some Uses of Twistors in Field Theory,
= Integrable Many-Body Systems and Nonlinear Equations, as well as 3 new working seminars,
= Nonequilibrium Quantum Field Theory,
= QCD in Small Dimensions,
= Modular Spaces of Complex Curves.

10 publications of MSc and PhD students in 2023, 7 of them without co-authors, participation in 3 international conferences with presentations.

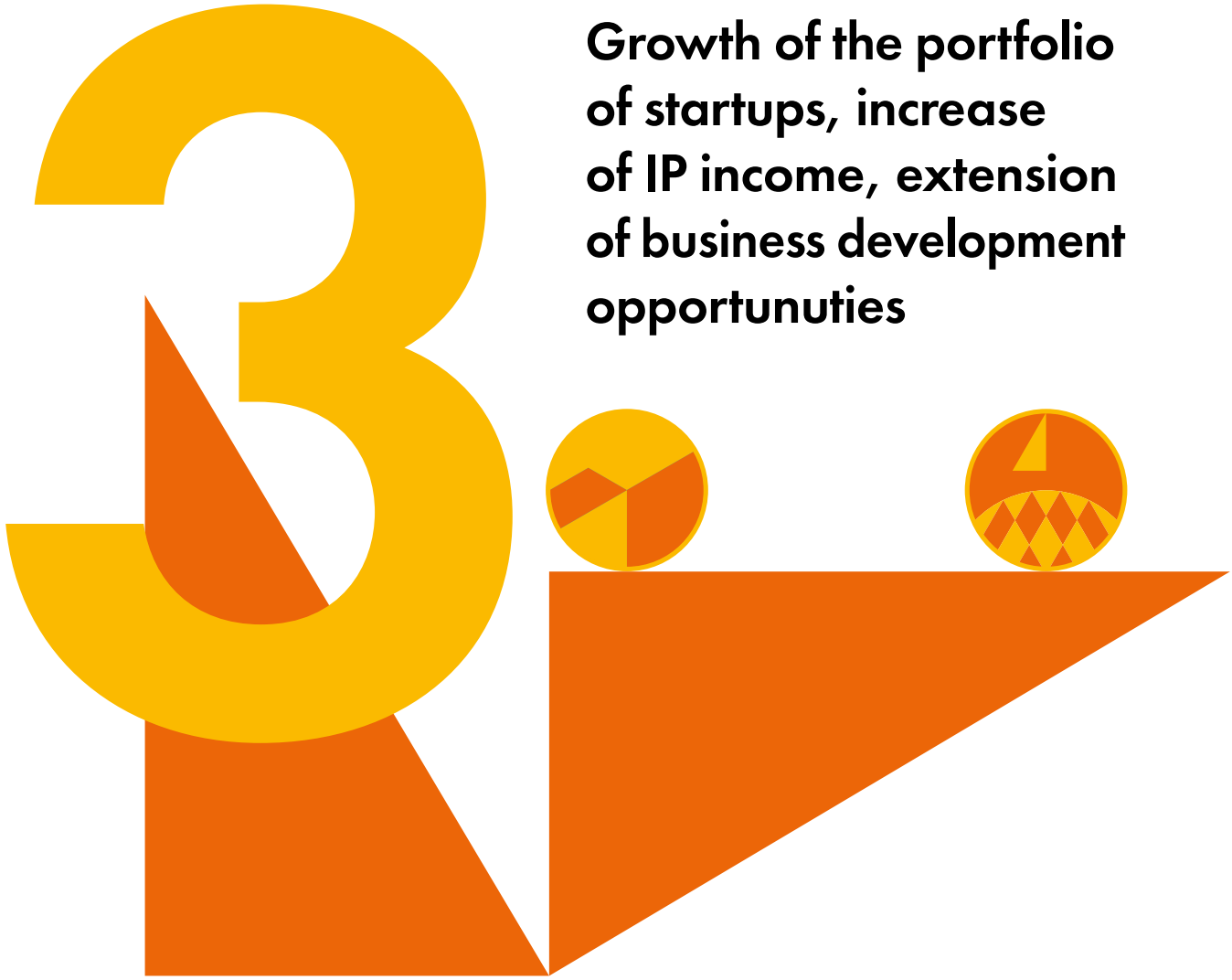
Reports on the topic of the integer eigenvalues of 'pedestal matrices'

Reports by Professor S. Shlosman on the topic of the integer eigenvalues of 'pedestal matrices' at the Kolmogorov-120 conference and at the Mathematical Forum in China

= = R. Kenyon, M. Kontsevich, O. Ogievetsky, C. Pohoata, W. Sawin, S. Shlosman. The miracle of integer eigenvalues. http://arxiv.org/abs/2401.05291

Student schools and international conference

The 4th Spring Student School on Mathematics and Physics (Skoltech, April 30 – May 6) and the International Conference 'Geometry and Integrability' (Skoltech, HSE Univ., September 18–22). More than 50 MSc and PhD students participated in the school, and about 40 reports were made. 21 report was made at the conference by scientists representing Russia, China, the Netherlands, France, Great Britain and the USA.



Growth of the portfolio of startups, increase of IP income, extension of business development opportunuties

Driving Entrepreneurial Spirit

The Center for Entrepreneurship and Innovation delivers a comprehensive program that shapes a technological entrepreneurship ecosystem and creates a startup 'belt'. The program was founded jointly with MIT, and today it includes the educational track, tools for ecosystem development, IP management, investors relations and business development.

The Center guides and supports teams from 'idea' towards a technological product and its market launch. Nourished in the spirit of enthusiasm, creativity and ideas exchange, startup teams quickly reach the level of working prototypes that attract both consumers and investors.

Educating future entrepreneurs

The program allows to rapidly raise entrepreneurial competencies, guiding students from idea to a project capable to attract financial support from the institutes for development. For this purpose, a 'startup funnel' is in place, which is a chain of courses and trainings, opened with Innovation Workshop.

In 2023, more than 300 students passed through the 'funnel' and more than 60 projects through the Innovation Workshop. Teams prepared 17 applications to Skolkovo Foundation and Foundation for Innovation Advancement, more than a half of applications reached success.

'DRONSPECT' project case

August	September	October-November	December	January
Idea of pre-flight inspection of aircraft by creating a digital twin using computer vision implemented in a drone swarm (Prof. Panayi)	Project presented at the 'Innovation Workshop', a team created. The first prototype introduced	Project incubation in the 'Startup Funnel'	Application to the Skolkovo Foundation	Application approved. Company established, work on a pilot prototype launched

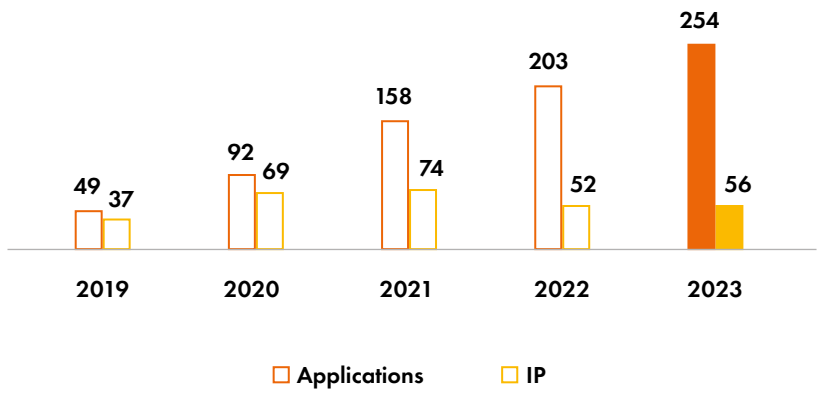

Skoltech
Triple Point
Skoltech
Triple Point
ACCELERATE
Winner
Skoltech
Triple Point
ACCELERATE
2nd place
Skoltech
Triple Point
ACCELERATE
Audience
award

IP management

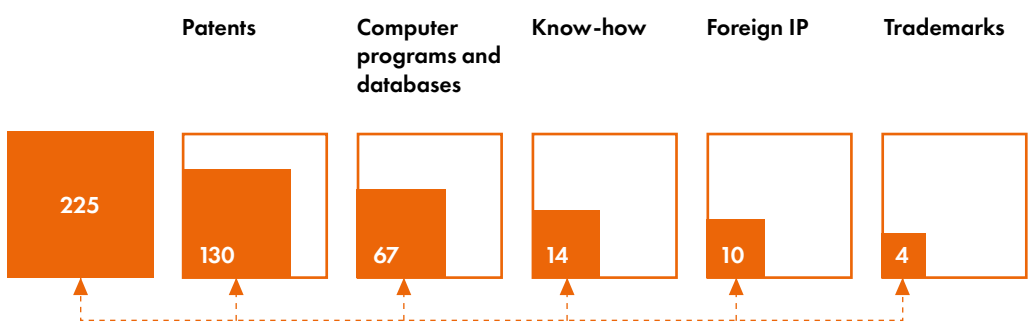
IP management is the most important method of ensuring return on investments in the long term through licensing patents and other IP objects. By the end of 2023, the active IP portfolio included 225 items, 56 patent applications were filed and 50 title protections received.

The income from IP exceeded 700 mln Rub. Among the most significant results is the sale of IP for 4/5G – this IP was shaped for several years, also with support of NTI Foundation and the Ministry of Digital Development, Communications and Mass Media, and was implemented in a mutually beneficial transaction which has social and financial impact.

Patent activity



Active IP Portfolio



Startups

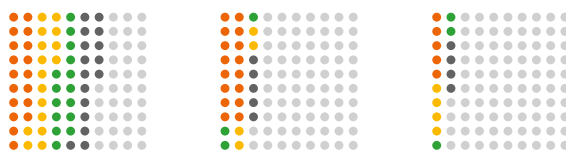
To develop a technology innovation ecosystem, Skoltech has a 'startup club', and a translational research program. The total number of companies in Skoltech startup 'belt' reached 166, while the annual revenue of such companies exceeds 1 bln Rub. 104 companies are in Skolkovo ecosystem.

In the student entrepreneurship track, efforts were made to a growth of applications to the Foundation for Innovation Advancement, viewed as a proper mechanism of high-quality expertise and funding for early-stage companies. 14 startups received grants, including ARSI (a winner of the Energotechnohab competition, software for training engineering specialists using augmented reality technologies), ANRIA (software and hardware complexes based on virtual and augmented reality for orientation in complex spaces and providing information based on user's location), and EASY (software and hardware solutions to increase crop yields).

The other success of the year is Skoltech participation in the national ranking 'Top 1000 university startups'. Among engineering universities, Skoltech was represented with a maximum number of startups (22). MIG, Game R, PICSTECH, ARSY, Proxion, K-plus entered the list of 'top 100', while Prof. Titov (a founder and head of MIG company) was recognized as the national leader in the energy sector.

Skoltech ecosystem is a mix of companies of different stages. Examples of early stage startups were outlined above. Several startups are approaching the maturity level. Labadvance and K-plus received venture capital investments that allow to license patents from Skoltech. Rustor and MIG are making significant progress.

Startup Portfolio



	Prototypes	Entering the Market	Increase of revenue
Numbers of Startups	81	23	20
Skolkovo residents	38%	15%	12%

● Industrial equipment ● Software ● Service Industry ● Biotech

4

Best education in Russia in advanced areas of science and technology

MSc, PhD, professional education

MSc and PhD program development

The educational portfolio is aligned with the target domains and includes 12 MSc and 8 PhD programs. All programs are designed and updated by faculty, considering emerging trends and new opportunities that allow students to apply knowledge and competencies in applied projects. Programs' ultimate outcome and a measure of success are graduates, capable to design and implement completely new approaches and solutions.

New programs and tracks appeared in 2023 included Agrobiotechnology and Engineering, Applied Computational Mechanics, Photonics and Optical Technologies, Materials Technology, Computer Modeling in Applied Sciences, a '2+3 path' (MSc and PhD studies), 'Startup project as MSc Thesis'.
The course portfolio was extended with 35 new disciplines (over 210 courses in total).

In line with the Strategy, the project for redesign of the program portfolio was kicked-off with establishment of Industry Councils.

Educational process

Defenses

Skoltech defense system meets the highest standards and international practices for thesis requirements and qualification of experts. Starting from 2015 (first defenses) Skoltech maintains international composition of committees, also inviting industry experts. All defenses are conducted in English.

The MSc graduation class of 2023 included 238 students. 29 committees were composed of more than 140 of experts from Russia and abroad, including 20% of industry representatives. Examples of the best theses are outlined below:

Student	MSc Thesis	Supervisor
Kuznetsov Nikita	Medical Assistant System Based on Natural Language Processing	Prof. Ivan Oseledets
Stapran Andrey	Identification of Tumor-Specific Retro-Antigens Based on RNA-Seq and Immunoproteomics Data	Prof. Dmitriy Chudakov
Kuanyshova Ayaulym	Experimental Study of Strain-Rate Effect on Mechanical Behaviour of Fiber Reinforced Polymers	Prof. Ivan Sergeichev
Zhura Iana	Neural 3D Scene Reconstruction and Segmentation with Multi-Agent UAV (Unmanned Aerial Vehicle) for Optimal Navigation of a Quadruped Robot	Prof. Dzmitry Tsetserukou
Ilmenskii Aleksei	The Study of Bazhenov Kerogen Thermal Decomposition Products and Kinetics During Pyrolysis and Hydrous Pyrolysis in a Closed System	Prof. Mikhail Spasennykh
Pavlova Alina	Single-Crystal Ni-Rich Layered Cathode Materials for High Energy Density Li-Ion Batteries	Prof. Artem Abakumov
Molodtsov Vladislav	Beamspace Selection in Multi-User Massive MIMO	Prof. Andrey Ivanov
Grigorev Andrei	Vertex Operators for c = -2 Conformal Field Theories and Local Systems	Prof. Mikhail Bershtein

The PhD graduation class included 81 students. 60 students defended PhD thesis (39 PhD at Skoltech, and 21 defenses at external committees). Over 100 jury members from 33 countries took part in defenses, representing top ranked international universities (Harvard, Columbia, Technical University of Munich, KU Leuven) and leading Russian research institutes. Defenses were also organized under joint PhD programs (Curtin University, Ben-Gurion University of the Negev, KU Leuven).

Industrial immersion

The Industrial Immersion is a compulsory part of MSc studies. Traditionally, immersion is organized at large industry players, small enterprises and Skolkovo startups.

In summer 2023, 210 projects were completed by students in 104 companies spread from Moscow and St. Petersburg to Tyumen, Novosibirsk, Krasnodar, Chelyabinsk, and Yuzhno-Sakhalinsk. Positive feedback was shared by both students and companies. More than a half of companies supported further cooperation (e.g. thesis preparation, employment programs). All immersion projects were presented at the annual Industry Day in October, attended by more than 600 participants from industry and academia.


ДОБРО ПОЖАЛОВАТЬ
В КВАНТОВЫЙ МИР
Best Project


Skoltech
Industry

Examples of industry immersion partners

Artificial Intelligence	Life Sciences and Health, Agro	Advanced Materials and Engineering	Energy Efficiency and Energy Transition	Telecom, Photonics and Quantum Technologies
Largest Russian IT companies, banks	Genetico	Largest Russian oil and gas companies,	K-plus	IPG Photonic QBoard
Moscow Stock Exchange	AIRI	Tyumen Petroleum Research Center	Basic technologies	TetraQuant
Avito	BARI – NN	Novosibirsk Scientific and Technical Center	Rustor	Tirphotonics
IRA Labs	Motorica	Digital Petroleum	Topaz. Inenergy	The Third Opinion Platform
Ashmanov Neural Networks	MiLaboratory	Laboratory of Computational Mechanics	Rosatom	Select Russian IT companies
The Third Opinion Platform	MRM Proteomics R	Spheroid Revolution	Cyberphysics	
	Sensortech	TMK	Siberian Generating Company	
	SOKO	Eco Energy	Russian Power System Operator	
	TetraQuant	Cyberphysics	Spheroid Revolution	
	Eco Energy	Tsuru Robotics		
	M-GRANAT			

The highlighted companies are Skolkovo startups.

Center for Teaching and Learning Excellence

High quality of programs requires continuous improvement of teaching methods, design and application of new approaches and practices. The Center for Teaching and Learning Excellence implements a comprehensive program for faculty and staff involved in program delivery.

The 'Innovations in Education' grants were awarded to faculty as a support in developing courses in catalysis of sustainable development, blockchain, computer vision and AI in robotics, use of chatbots. Agenda of seminars and workshops included insights of Skoltech educational model, courses requirements, teaching practices, and hybrid learning.

Recognition of teaching excellence was also on the agenda: Faculty Teaching Excellence Awards were announced at the Commencement Ceremony.

Library

Main efforts targeted finding alternative access to resources and databases, earlier restricted due to sanctions. By the end of 2023, up to 80% of resources used by students and faculty became available. Library spaces were developed in line with the concept of being a campus academic center.

Talent Recruitment

Educating top specialists requires recruitment of strong applicants focused on education, frontier research and technological entrepreneurship. Skoltech designed a stable recruitment system that meets this goal. As of today, outreach and recruitment ensure a wide coverage, while various competition tools and formats allow to conduct a comprehensive assessment of applicants' knowledge, soft skills and professional aspirations.

In comparison with 2022, the campaign was wider as for a number of events and geography – Skoltech was presented in Kazakhstan, Azerbaijan, and Malaysia. Outreach in Russia was expanded, showing 150% increase of universities. In addition to open doors, lab tours, lectures and exhibitions, new formats were piloted, e.g. faculty lectures at universities of Thailand resulted in a growth of applicants to the Scholarship program of the Princess of the Kingdom of Thailand.

The Olympiad track was also in place. For the fifth year in a row, the olympiad 'Mathematics of Machine Learning'

was held with the HSE. 5 winners of the National olympiad 'I am a professional' were also enrolled.

The class 2023 is represented with 267 MSc and 149 PhD students, 38% of whom have diplomas with honors.

24% of students are foreigners (Italy, China, Mexico, Serbia, USA, Turkey, Thailand, Kazakhstan, Ecuador, Peru). Skoltech also enrolled graduates of top international universities (e.g. Cambridge, Delft University of Technology, Texas A&M University).

Class 2023

Skoltech is about opportunities to outdo yourself

I think there is hardly anyone who would refuse an offer to study among the best students with the most qualified professors, implement projects in laboratories with the most advanced equipment, as well as, in addition to professional skills, upgrade soft skills and train entrepreneurial mindset.
I expect that Skoltech will give me exactly the applied knowledge that is currently in demand in the industry, and after graduation I will receive that once in a lifetime offer.

Artem Myshlyaev

MSc in Engineering Systems

Skoltech is about opportunities to make your dreams a reality

I accepted Skoltech's offer because it appeared to be a unique opportunity to join an advanced educational institution, specializing in what I am interested in – machine learning. Coming to Skoltech for a joint MSc program with HSE after success in the Olympiad was a big surprise, and confirmation that I am on the right trackt. Skoltech program, opportunities to study modern technologies and join R&D teams and industrial partners were the key factors of my choice.

Dmitry Topchiy

MSc in Data Science

Skoltech is about freedom

I decided to study at Skoltech because I got interested in a program given here. Also I wanted to have a closer meeting with Russian cullture. I expect opportunities to polish my skills and gain knowledge from projects and staff.

Moreno Fuentes Luis Francisco

MSc in Advanced Manufacturing Technologies

Skoltech is about innovation

I chose Skoltech because it is a unique university that combines world-class education with an atmosphere of research and entrepreneurship. I expect Skoltech continues being a great place to develop science and technology and becomes one of the most prestigious universities in the world.

Criollo Delgado Luisa Maria

PhD in Life Sciences

Skoltech is about friends, development and opportunities

I've heard that Skoltech is a place where scientific discoveries aren't neglected but are implemented in reality. I am sure that new challenges await me here, which will help me to develop both as a person and as a scientist.

Daria Demeshko

MSc in Applied Computational Mechanics

Skoltech is about innovation, opportunity, a start for future

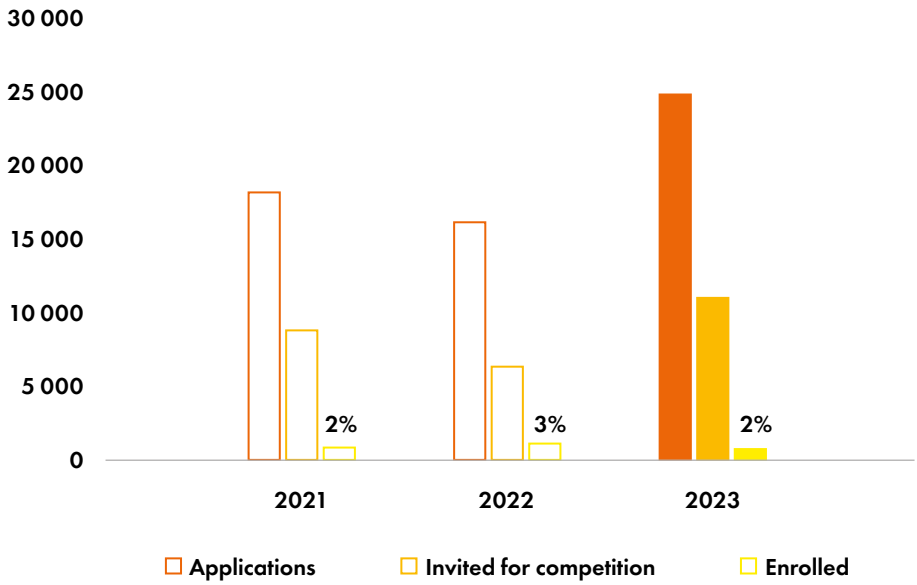
I chose Skoltech because I always wanted to deepen my knowledge in photonics, and Skoltech is perhaps the only place in Russia with English program in photonics and possibilities of multidisciplinary courses. A significant plus is that Skoltech represents a unique combination of academic science and young, growing startups.

Qian Lujiang

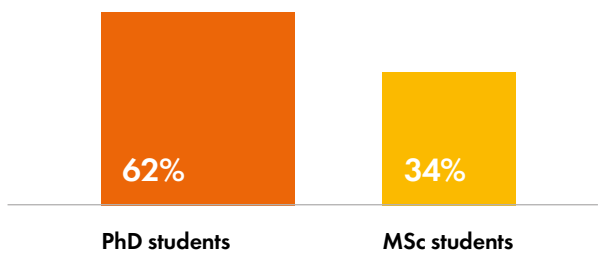
MSc in Photonics and Quantum Materials

Admission campaign 2023

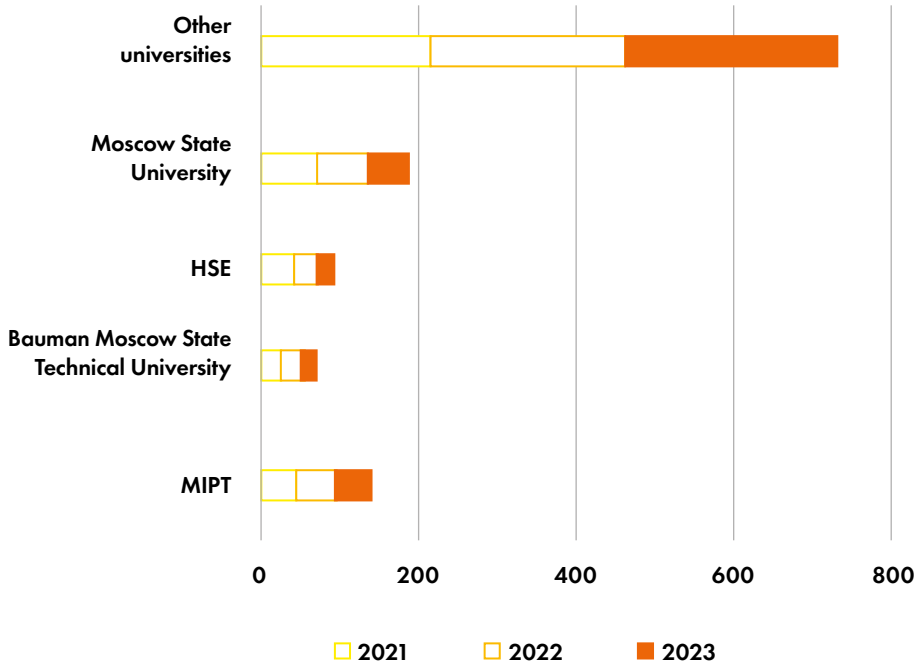
Recruitment funnel



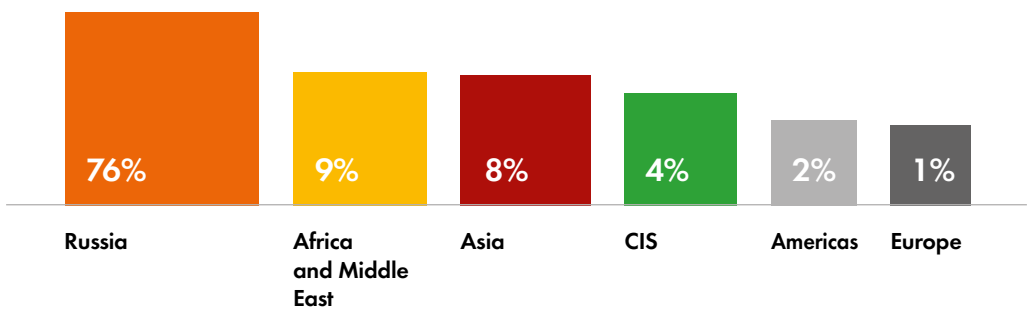
Diplomas with honor



Enrollment by university



Enrollment by geography



Professional education programs

Skoltech continued to develop professional education for management and engineers of high-tech industry based on a product-based approach. In total more than 20 programs were delivered for over 460 participants. The portfolio included 42 programs.

Product competitiveness on the market was confirmed with ongoing demand, for example, for the programs of the Materials Center, as well as a growing interest for new programs. 'Advanced additive manufacturing technologies' was delivered 4 times, while 'Digital certification of products made from polymer composite materials for general civil purposes and transport infrastructure facilities' was delivered 2 times. The Engineering Quest was organized for Evraz for a second time. Also, Skoltech delivered programs for advanced engineering schools of Russian universities (Bauman Technical University, Samara State Medical University).

Market promotion was continued. Kazakhstan became the new region on the agenda, where Skoltech presented professional programs at the Innoprom Exhibition in Astana.

Training in Skoltech was the exciting journey to the world of machine learning in medicine. I would specifically note the internship, where participants could apply knowledge in practice and successfully defend group projects – this is important for our research. We thank Skoltech for individual approach: relevant scientific material was tailored, and top world scientists were involved in teaching. We are proud of our achievements and are ready to apply knowledge in solving complex problems in the field of healthcare.

Anton Ivashchenko, Director of the Advanced Medical Engineering School of SamSMU

Our team of Rosatom Innovation Hub was trained in the program 'Advanced technologies of additive manufacturing'. We highly appreciate this training. The teaching staff has all knowledge and experience to form competencies required in launch of 3D printing projects. In the training, we reviewed all existing printing technologies and materials. The knowledge was immediately brought into practice in Skoltech labs. We thank Skoltech team for this training.

Galina Wilhelm, Head of the Department for Development of Innovative Projects of InnoHab

5

Education of a full cycle – start of bachelor prorgams in advanced areas of science and technology

Unique baccalaureate

Main outcomes included development of regulatory documents, obtaining a state license and a permission from the Skolkovo Foundation for programs in IT, Materials Science and Neuroscience. BSc Materials for Energy Generation, Conversion and Storage in collaboration with the Mendeleev University became the first program approved. The pipeline of programs in design includes IT program with Innopolis and Systems Neuroscience with HSE.

Skoltech baccalaureate was opened with enrollment of 22 students to the program 'Materials for Energy Generation, Conversion and Storage'.

Skoltech
welcome
Skoltech
welcome
Skoltech
welcome
Skoltech
welcome

6

Digital landscape for innnovation solutions, development of educational environment, and advancing students' development

Digital university

Digital landscape and services

A university targeting frontiers, requires a solid technology base to maintain a high quality educational process, starting from submitting applications. In 2017, Skoltech became the first university in Russia which fully digitalized its admission, which allowed not only to successfully complete the recruitment campaign, but also even increase a conversion of applicants during pandemic.

The digital landscape project targets a new model which will transform management of the whole educational process. The model is about a full- scale digital landscape, which elements, on the one hand, will become the ergonomic interface for interaction with applicants, students, and alumni, and on the other hand, will ensure a data-based management of processes.

In 2023, localization of the open version of LMS Canvas was carried out, while the organizational base was prepared to bring IT systems in line with requirements of the regulator, coming into force in 2024. The application system was improved in terms of ergonomics. The process of implementing a master data system is underway to create a single information base, and synchronize information processing.

7

Career developmnet program in three tracks: academia, R&D, technology entrepreneurship

Student development, alumni relations

Scholarship program

The scholarship program targets professional growth and excellence in academia, R&D and entrepreneurship. All scholarships are awarded on a competitive basis.

The scholarship fund of 2023 amounted to 644 mln. rub. The 'Development scholarship' was awarded for papers in prestigious journals, best conference papers, awards in technology competitions received by students in neuroscience, AI, robotics, engineering, sports programming, bioinformatics, hydrocarbon recovery. Startup teams with projects passed the expertise of Skolkovo Foundation and Foundation of Innovation Advancement, also received support.

Students were also successful in external scholarships, including those of the President of Russia, Government of Russia, Tinkoff, Vernadsky Foundation. For the first time, Skoltech received quotas for the most prestigious state scholarships – scholarships of the President of Russia, and scholarship of the Government of Russia.

Skoltech's PhD students Denis Kuznedelev, Anton Razhigaev and Nikita Gushin receivers of V Yandex ML Prize international award.

Scholarships and prize winners

Leaders of IT industry

Sergey Blintsov,
winner of the First Prize

Leaders of Digital Transformation (Severstal)

Evgeny Frolov,
Daria Frolova,
1st place

Vyacheslav Kozitsin,
Yuri Katser,
2nd place

International Yandex ML Prize in Machine Learning

Anton Razzhigaev,
Aibek Alanov
(nomination 'Researcher')

Denis Kuznedelev
(nomination 'Yandex Researchers')

Nikita Gushchin
(nomination 'Debut scientific publication')

Student Startup (Federal project 'University Technology Entrepreneurship Platform')

Egor Grishin
(BuildLogic)

Vitaly Kazaku
(ARSY)

Anton Labutin
(Speechy)

Yanislav Morozov
(Naval Sheep)

Scholarship of the President of the Russian Federation

Anastasia Sapach
Margarita Chetyrkina
Alexey Fedoseev
Ayomikun Bello
Alexey Kuzin
Maria Dronova

Scholarship of the Government of the Russian Federation

Daria Travnikova
Ivan Apanasevich
Olga Kovaleva
Sergey Perkov
Ilya Khomchenko
Artem Vazhentsev
Denis Kuznedelev

Academic mobility

The program enriches student research experience, expands professional network and promotes integration with international community. The program is implemented on a competitive basis, where the academic excellence is a compulsory requirement.

In 2023, students made almost 200 internships to top research laboratories and centers, as well as attended conferences. The research projects were competed in Fudan University, Mohamed bin Zayed University of Artificial Intelligence, KAUST, Ben Gurion University of the Negev, Technion, NUS, KU Leuven, EMBL, and others. Several examples of success, achieved with support of academic mobility:

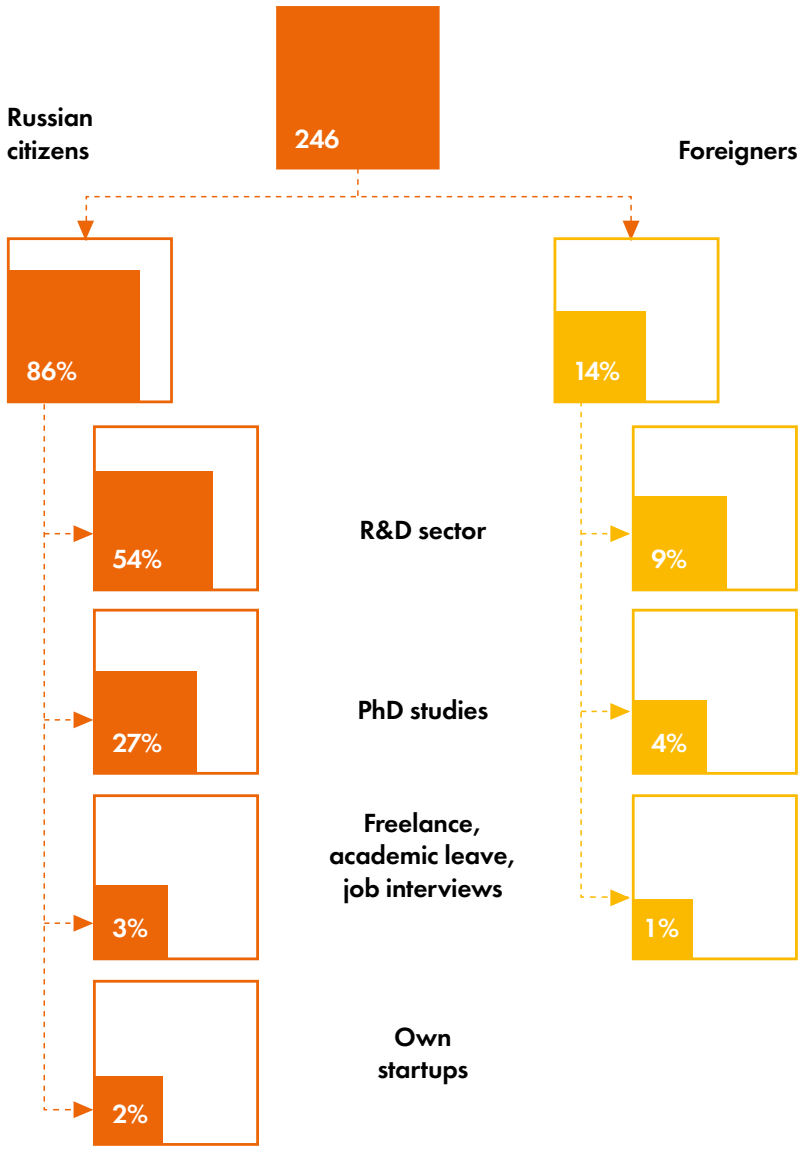
- Karyna Karneyeva presented a report at 10th FEMS Congress of European Microbiologists and EMBL Symposium: New approaches and concepts in microbiology.
- Semyon Shraer, Nikita Luchinin, Artem Dembitskiy, and Mikhail Agapkin won the award in the 8th International Conference on Sodium Batteries in Liyang, China.
- Artem Galliamov and Gleb Strizhnev won awards at the International Field Exploration and Development Conference in Wuhan, China.

Career opportunities and employment

Graduates' employment success is a reflection of the system for talent recruitment, education, and development. The class 2023 showed a high percentage of employment in top R&D companies in IT, banking, oil and gas, engineering, photonics. Graduates, willing to continue academic career, mostly stayed at Skoltech on junior research positions.

Skoltech model of interaction with employers is based on a career support program, lectures and seminars, company tours, technical interviews, test cases, hackathons, and job fairs. During the year, Skoltech expanded a pool of partners in the sectors of biotechnology, oil and gas, data analysis and AI.

Graduates 2023 in Russia



Profile of Graduate Class 2023

Artificial Intelligence

IT companies	Researcher, data scientist, 3D CV/DL engineer, analyst, robotics engineer, junior research assistant, computer vision engineer, machine learning engineer, developer analyst
Bank sector	Computer Vision Developer, data scientist
Digipax	Computer Vision Engineer
GlowByte	Analyst
VisionLabs	Computer Vision Researcher
IRA labs	Team lead, deep learning engineer
Skoltech	Research engineer
Skoltech, MIPT, HSE	PhD studies

Life Sciences and Health, Agro

Neiry	Neuroscience specialist
Rapid Bio	Junior analyst
VisionLabs	Researcher
Institute of Gene Biology	Junior research assistant
Institute for Information Transmission Problems	Laboratory researcher
MIPT	Laboratory researcher
R-Pharm	Junior researcher, intern researcher
Skoltech	Junior researcher, researcher, PhD studies

Advanced Materials and Engineering

Oil and gas companies	Developer, engineer
AXENIX	Analyst
Digital Petroleum	Research Engineer
Terralink Global	Product Manager
Anria Research	CEO
Geonom	CEO
Engineering Centre Of Railway Transport	Engineer
Kamaz	Engineer, process engineer
Sigma Lab	Engineer
Skoltech	Intern, Junior researcher
NTI Competence Center	Engineer

Energy Efficiency and Energy Transition

Skoltech	Research engineer
Megatech	Big data analyst
Proenetra	Senior analyst
Joint Institute for High Temperatures of RAS	Junior research assistant
K-plus	CEO
IT and oil and gas companies	Research engineer, Intern researcher

Telecommunications, Photonics and Quantum Technologies

Ministry of Finance	Analyst
Sintels	Research engineer
Rainbow company	Software engineer
TetraQuant	Researcher
IPG Photonics	Researcher
Skoltech	Junior researcher, PhD studies
SIBUR	Intern
SOYUZSNAB	Chemist

Advanced studies

Skoltech	PhD studies

Juliana Tsvetinovich

Skoltech researcher, was the only scientist representing Russia in the Global Young Scientists Summit in Singapore in January 2024 (PhD, Physics, 2023)

My fascinating journey at Skoltech started in 2019 when I became a PhD student in 'Physics' program in the Photonics Center. I started in the Biophotonics Laboratory under supervisor of Prof. Gorin and co-supervisor Prof. Korsunsky. I basically completely changed the field of research since as a MSc student in MISiS I studied development of hybrid materials based on collagen and ultrahigh molecular weight polyethylene for reconstructive surgery.

My decision to join Skoltech became a turning point for academic and professional development, as my studies here changed everything: I got the opportunity to join academic research and learn from world-class faculty.

When I came to Skoltech, I was introduced to the field of diatoms, at the time I didn't even know what it was: it was difficult to imagine working with living biological objects, since I was a 'pure physicist'. I received a great support from my supervisors and four years later I defended the PhD thesis on optical and mechanic properties of food. I published more than 20 papers on diatoms, two book chapters, also made reports at more

‘My journey at Skoltech made me a confident and competent researcher’

than ten conferences, and now many of my peers from different international universities associate my name with diatoms, which is very good for me as a young scientist.

Since the research is fully interdisciplinary, it greatly expanded horizons and gave me many new ideas and methodologies. I had a chance to work with colleagues from different universities in multiple research areas. Collaboration, support, and exchange of ideas helped me to achieve notable results: in particular, to create a new laboratory for growing diatoms, which can now be studied at a completely new level. All of this is thanks to Skoltech support of and a RSF grant.

One of my major achievements is participation in the Global Young Scientists Summit in Singapore, where I represented Skoltech on the world stage, met with Nobel laureates, and talked about my research as a moderator at the ‘Physical Sciences’ section.

Skoltech is a perfect place for anyone willing to advance in the chosen field. Here I was immersed in dynamic academic environment, had many opportunities such as participation in world-level conferences, international summits, presentations and papers in respected journals. My journey at Skoltech made me a confident and competent researcher, with a broad view and happy with what I am doing.

My dream is to become a faculty at the Institute, where I can not only transfer knowledge and inspire young scientists, but also conduct research addressing scientific and technological challenges.

Vitaly Kazaku

A PhD student of the 'Petroleum Engineering' program, a leader of ARSY startup, a winner of Grand Prix of the Student of the Year competition Moscow — 2022' (a graduate of MSc Petroleum Engineering, 2023)

It all started during the course of Prof. Alexey Nikolaev, where he, as a mentor of my project, explained how to establish a startup based on the idea. There I also gathered the first team, which conducted interviews, analyzed theories and created a prototype for Skoltech Triple Point competition, where we won the first prize and, what is most importantly, gained the first potential partners in the oil and gas company.

After going through all stages of creating a startup, we advanced the project, finalized the presentation, made a market research and

‘The idea came during my internship. Today the startup is developing the interactive platform based on augmented reality technology for metallurgical, mining and oil and gas companies’

expanded the team. Prof. Cheremisin played a huge role in our development: he introduced us to the industry and helped to identify the points of growth in the companies.

Today we are developing the interactive platform based on augmented reality technology. Large companies often face a problem in training young professionals. Training should be conducted either at a dangerous industrial facility where there is a risk of injury, or teach a theory in special centers, using videos and presentations, which is not always effective. The ARSY project allows to organize a safe interaction with staff, demonstrating complex equipment, simulating dangerous production situations. At the same time, there is no need to buy expensive VR headsets and PCs when you work with ARSY: a smartphone with a camera and Internet is all that is required.

In future, we view our company wider than a provider of professional education. EdTech is a growing niche, and we believe that ARSY program will become a full-fledged course in the universities.

‘My dream is to create cool and smart robots. Skoltech helped me to make it a reality’

Mikhail Kurenkov

Head of the Hardware Development and Production Group, Yandex Robotics Center (a graduate of MSc ‘Space and Engineering Systems’, 2019; PhD in Engineering Systems, 2023)

When I joined Skoltech, it was probably the only place in Russia that dealt with robotics on the international level. I chose the Robotics Laboratory and don’t regret it: Skoltech was the incredible launch of my career. First of all, my supervisor, prof. Tsetserukou, helped and provided all opportunities: he gathered the excellent student team, with many peers I am working with.

Courses in robotics, machine learning and deep learning helped me. I got a great support from The IoT Center. With their help my team and I were able to complete a project on the inventory robots for Decathlon.

My first achievement at Skoltech was participating in the EUROBOT competition, where we won in Russia and were able to go to France, where we took the 5th place.
Then I participated in a project to create an inventory robot. We were able to launch robots at ten sites: robots could travel among people and scan goods. After such a great start at Skoltech, I joined the Yandex team: now I am the Head of the group, continuing to work on robots.

I had a dream – to create cool and smart robots. And today I am fully confident that Skoltech helped me to make it a reality.


my blood
Skoltech

Student life, alumni relations

Skoltech means exciting and dynamic student life. Many events are held annually, including Talent Show, International Night, Student Club Fair, Donor Day, and Student Initiation. Students also have opportunities to join more than 30 clubs in music, sports, linguistics, and other areas of interest. Sports clubs are of a special pride – students and alumni represent Skoltech in multiple competitions.

For example, a volleyball team took the 3rd place in the Business Champions League.

Alumni relations were maintained via digests and a student mentoring program. For the first time, events with alumni participation were organized in Skolkovo Gymnasium. The Ambassadors' program was ongoing as the association of graduates around the world.

8

Program of personnel's professional growth

Human capital development

Development and implementation of frontier technologies require professional teams of the highest level. As of today, Skoltech is a unique community capable to address these tasks.

Faculty have unique competencies and rich experience: the vast majority (85%) have international background, which is important for implementing advanced R&D projects. Centers, laboratories and challenging research tasks continue to attract new talents. Every year, research and project teams conduct more than 200 projects.

The HR agenda prioritizes favorable environment for working and career growth. The employer's value proposition targets high recruitment standards, wide incentives and career opportunities, dynamic intellectual culture. Skoltech also follows the initial model, providing academic staff favorable conditions for research (e.g. keeping a low student per faculty ratio (8:1), a system of research interns to support R&D projects).

In light of challenges of 2022, when 15% of faculty terminated contracts, the tasks for 2023 focused on overcoming further volatility, improving a pay and benefits system, a higher operational efficiency, and expansion of professional development program.

Comprehensive measures resulted in a decrease of a personnel turnover by 4% compared to 2022, and new faculty appointments. The appraisal, results recognition and goal setting cycle was completed, while professional development program covered all personnel categories.

Career development program

Advancing competencies and skills of personnel was made through trainings, both inside and outside Skoltech. In 2023, the program was significantly expanded so that almost 50% of personnel could attend professional courses in such areas as change management, patenting, audit and finance, HR, personal data protection, occupational safety and security, project management. Seminars for faculty and teaching staff on programs, course design, assessment tools and advanced teaching methods were organized by the Center for Teaching and Learning Excellence.

Results recognition was made on the base of the appraisal cycle: 16 faculty were promoted, while 25 most talented researchers, demonstrated excellence and capacities for further growth, received faculty appointments.

Talent recruitment

Two open calls resulted in a resume of a growth of faculty cohort after losses in 2022. By the end of 2023, Skoltech had 134 faculty.

Efforts to strengthen employer's brand were continued. Main results include a stronger visibility on HR platforms and forums, advancement of Skoltech profile on the DreamJob.ru portal and work with reviews, which allowed to reach a '4.0' rating, participation in employers' ranking (hh.ru). The HR also completed staff loyalty surveys (eNPS), exit interviews and analysis of factors influencing decisions to leave Skoltech. All results are taken into account in planning HR activities for 2024.

Personnel profile

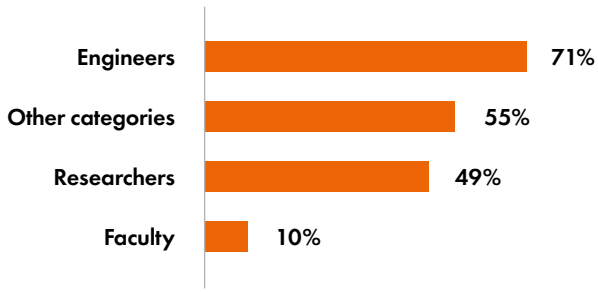
1405
employees

38%
women

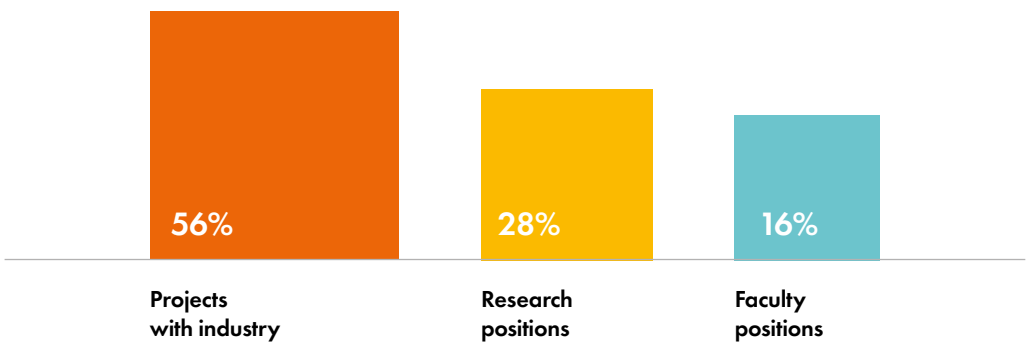
85%
Faculty with international experience

Personnel by age groups

Employees under 35



Faculty international experience



Incentives and pay system

Monetary and non-monetary incentives are based on the principles of competitiveness, internal fairness, flexibility of tools for appraising professional qualification and results.

Skoltech completed the transition to the new pay system, also conducting the salary indexation. Following the pilot appraisal cycle, 87 employees received salary increases. Individual KPIs for management were set.

The internal awards are integrated in the incentive program. 31 faculty received Excellence Awards for contribution to Skoltech results. 7 faculty received awards for quality of teaching, student supervision and mentoring. Staff awards were announced at the New Year party.

Health and well-being program

Skoltech offers a broad health and well-being program.

In 2023, medical services were expanded, while discounts in Moscow gyms became available for all employees.

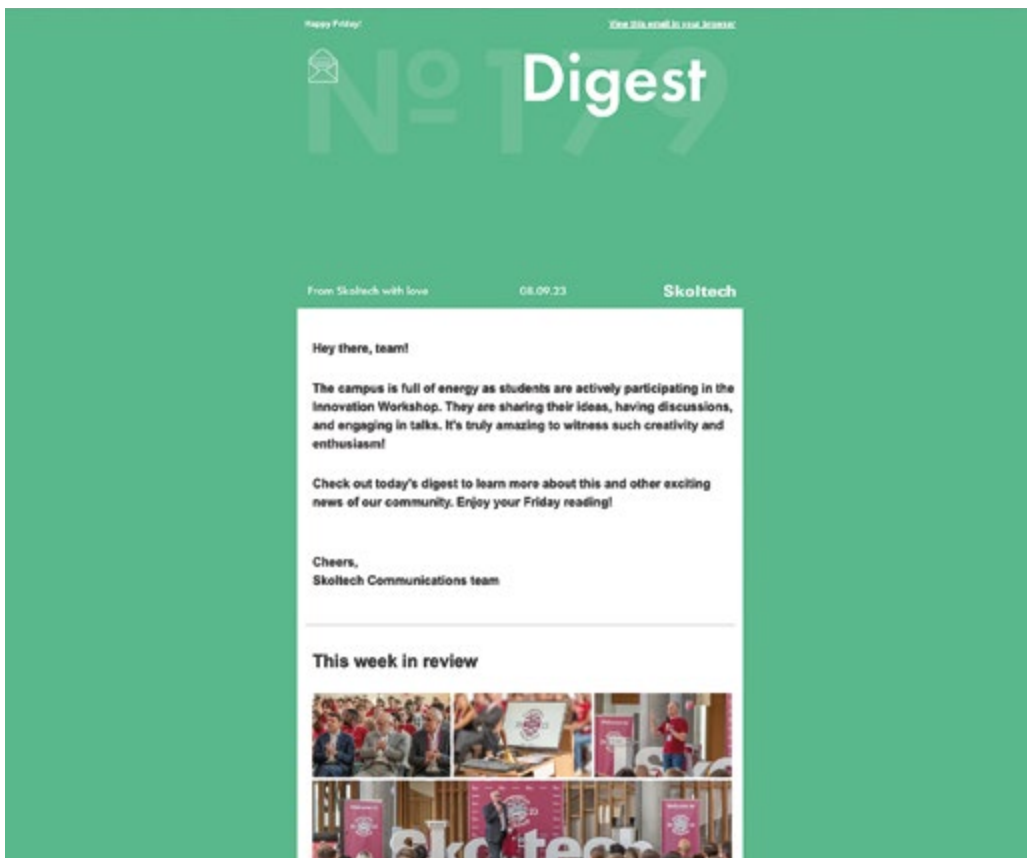
Considering complex laboratory facilities, the concept of 'zero' injuries was particularly important: audits of laboratories (control over implementation of complex technological processes) and large contractors and subcontractors were carried out. Trainings in electrical, industrial and radiation safety were completed. First aid trainings were also in place.

Internal communication

Advancement of internal communication was made by launching new projects, targeting a stronger community spirit and awareness of Skoltech results among employees.

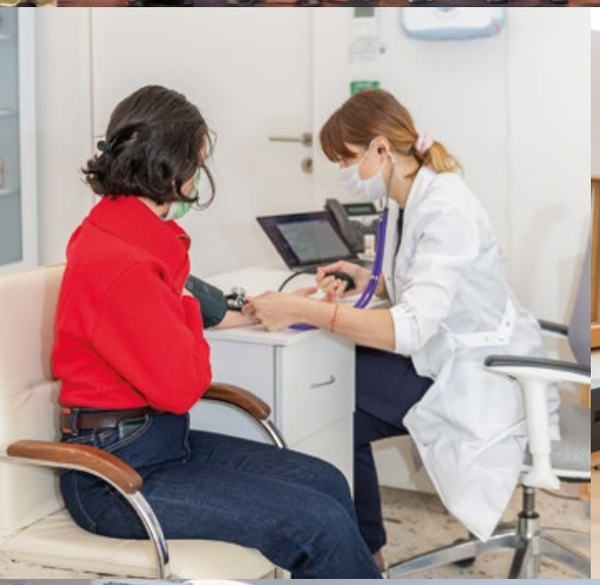
The running club was opened. Faculty, researchers, engineers, administration, students – all together completed more than 1200 kilometers. For the first time some runners finished 1 km races, while others finished the marathon. Skoltech birthday, New Year for employees and students, and a party for kids became already a tradition. 'Skoltech 10', which is a series of interviews with staff working in Skoltech for more than 10 years, was launched.

Internal digests, spread weekly, remained a main information channel for community, becoming more popular due to promotion and opportunities to share results. Internal newsletters were also actively used.




EXCELLENCE
AWARDS
Skoltech
class of
23


National Impact Innovator Award




Skoltech

Modern campus, favourable environment, efficient and convenient services

World-class campus in Skolkovo

‘East Ring’ laboratory construction

The completed projects included laboratory and office spaces of the Bio Center (1940 sq.m.), Laboratory of Aluminum panels (1211 sq.m.), Laboratory ‘Swarm of drones’ in the Digital Engineering Center (133 sq.m.). The Laboratory for prototyping integrated photonics devices in the Research Facilities Center (183 sq.m.) was established.

Several changes were approved in the construction plan, including development of laboratory spaces in Life Sciences and Health Domain, expansion of facilities of the Energy Center, and accelerated schedule of delivery of laboratories in Photonics Center.

Space development

The new projects included the creation of Kolmogorov VR Museum, arrangement of office spaces of the Energy Center, a foyer of the main entrance, creation of the wall of flags symbolizing all countries of community.

Campus laboratory project

Since 2022, Skoltech has been holding an expert role in the project for world-class campuses implemented in Russian regions. As a part of the project with Chelyabinsk, preliminary design work was completed. A new contract was signed for the project in Novgorod Veliky.


VR КОЛМОГОРОВ

Enabling programs

Governing bodies, management

Collegial governing bodies

Skoltech governance system is aligned with advanced practices of top technology institutes. It is also based on the principle of 'shared governance' – participation of stakeholders in development of the Institute through decision-making.

The governing bodies include General Meeting of Founders, Board of Trustees, and Academic Council. Their authorities are fixed in the Charter and respective policies, and cover key areas of Skoltech activities. The governance system was evolving in parallel with the Institute, and today it is stable, balanced, and transparent. Policies are monitored for compliance and relevance, while procedures are improved. Accounting for accumulated practices, in 2023 requirements for preparing documents were formalized to ensure high quality standards.

Interaction between executive management and governing bodies is carried out by the Executive Secretary. This role is assigned to Senior Vice President for Development.

General Meeting of Founders

The General Meeting of Founders is the highest governing body.

To strengthen the composition of the Board of Trustees after membership terminations in 2022, the Founders appointed 6 new members representing top national universities, development institutes, and governmental authorities.

The Founders also approved establishment of 'Skoltech Innovations' company, which will manage IP and shares in the charter capital of Skoltech startups. Skoltech subsidiary company 'TechSED' (Kyrgyz Republic) was established. Other decisions included approval of the new Charter, amended in provisions for target domains and authority to set own educational standards.

The composition of the Founders did not change and included Moscow Institute of Physics and Technology, Tomsk Polytechnic University, Institute of Solid-State Physics, Rusnano, Moscow School of Management, New Economic School, RVC, Foundation for Innovation Advancement, VEB.RF, and Sber.

Board of Trustees

The Board of Trustees ensures general management of the Institute, in particular, by approving Strategy, Financial Plan, annual reporting. The Board also support executive management with recommendations related to key programs and projects.

During the year, the Board held 3 meetings. Major decisions concerned approval of annual reporting for 2022, changes in the laboratory construction plan, Strategy update, Financial plan 2024 – 2026. Other decisions had a recommendation purpose and will be subject to approval by the Founders.

Academic Council

The Academic Council oversees research and education domains. The composition of the Council is approved by the Board, while authorities are defined in the Charter and relevant policies.

During the year, the Council held 7 meetings with agenda on Centers' strategies, approval of new educational programs. The Council also supported the concept of awarding Skoltech academic degrees, approaches and results of faculty appraisal. Faculty appointments were made in two open calls.

The Appointment, Promotion and Tenure Committee held 6 meetings, reviewing more than 50 appointment and promotion cases, as well as nominations for external awards.

The Educational Committee held 20 meetings, reviewing new programs, issues related to program portfolio, policies, students' nominations for prizes and awards.

The Research and Innovation Committee held 6 meetings to approve reporting on federal programs such as 'Artificial Intelligence' and 'Program for development of genetic technologies for 2019 – 2027.' Requests for research equipment and launch of new projects were also reviewed.

Executive management

The authorities of executive management are defined in the Delineation of Responsibilities (Authorities) approved by the President.

Skoltech has a strategy working group, authorized to review issues of strategic importance. 12 meetings were held to review the drafts of the Strategy update, and approaches for a budget.

The group also previewed materials for the Board of Trustees.

Regular management communication, which increases community understanding on plans and results, remained the priority. All-Hands, Directors' meetings, meetings with f administration were held to involve management of all levels in review of plans and improve decision-making.

Organizational structure

The changes in the structure mainly concerned research units.
New laboratories were established at the Applied Photonics Project Center, and Applied AI Project Center.

The structure of the Center for Entrepreneurship and Innovation was revised: new functions for incubation and acceleration of startups, technological and market audit were introduced.


Board of Trustees

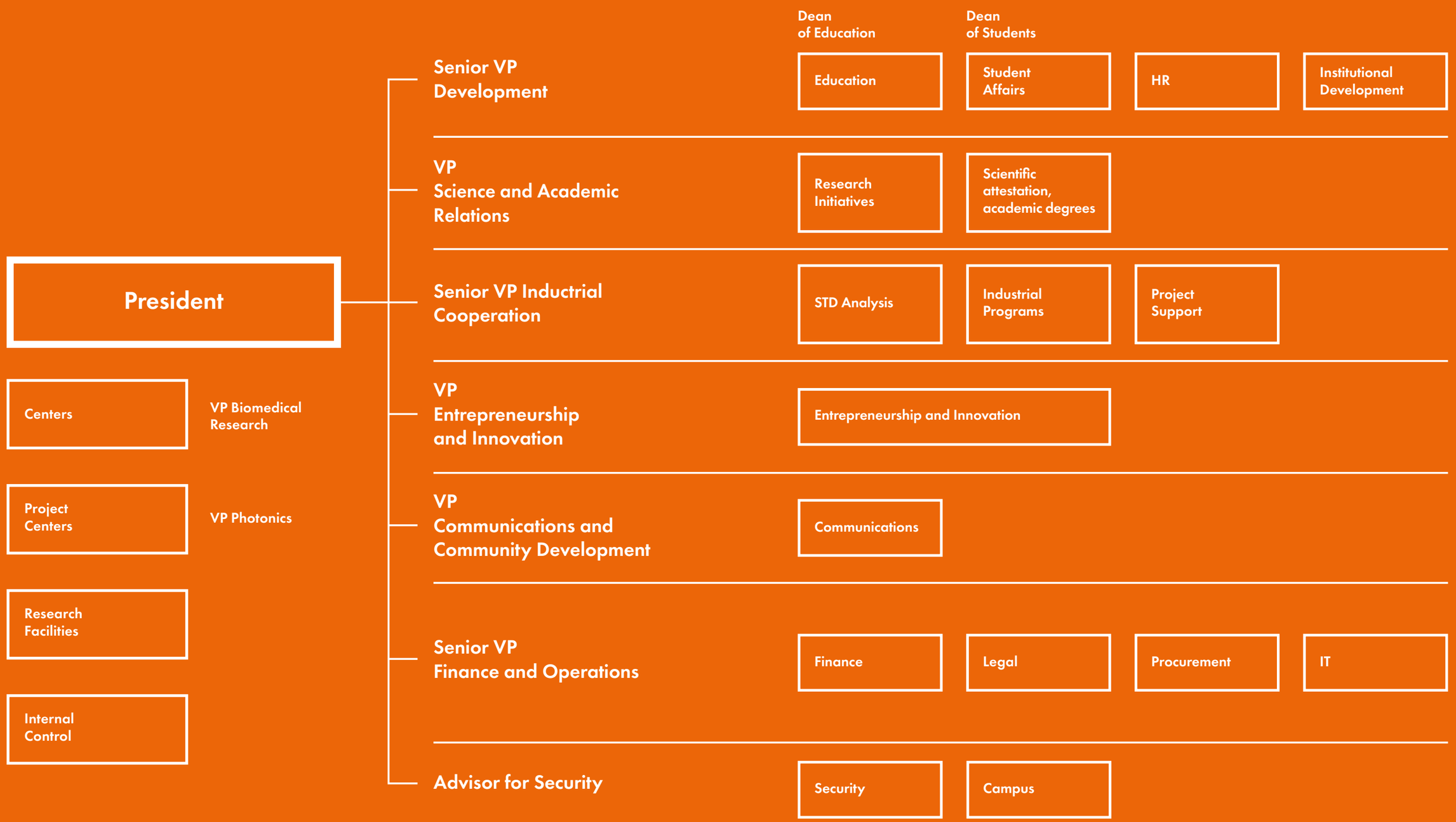

Skoltech today
Year ago SDN sanctions to Skoltech resulted in faculty leaves, termination of contracts, restrictions to intern
platforms. Today Skoltech has adopted and continues to facilitate scientific and technological development
2022
2023
5G4G
Open RAN
01
Development of
technologies, founding
02
Educating and training
specialists in target
domains to fill gaps in
03


ALEXANDER
KULESHOV


ARTEM
ABAKUMOV
TAIDEN
ANDREI
OSIPTSOV
TAIDEN


MIKHAIL
SPASENNYKH
TAIDEN
IVAN
SERGEICHEV
TAIDEN

Organizational structure



Annual planning and reporting cycle

The results of the planning and reporting cycle included updates introduced to the Strategy, KPIs, and Centers' programs.

Quality of planning was improved through cascading strategic KPIs to executive management and Directors. Operational plans 2024 were developed to bring the updated Strategy into operations.

The Annual Report 2022 was presented at the annual competition, organized by RAEX national rating agency. The Report received 5* certificate and became the best one among universities. The jury highlighted high quality and standards in presenting information.

Skoltech Annual Report 2022 received '5 stars' certificate for excellent quality and reporting starndards, as well as become the best one in the group of universities at the RAEX annual conference on corporate reporting

Policy making

The policy making is performed in a way to target favorable environment, aligning formal regulations with processes and procedures.

The main results included updates in policies for the pay system, and performance appraisal and goals cascading cycle. New policies in research and education were issued for autonomous awarding of Skoltech degrees, procedures for PhD defenses, admission rules, and a new '3+2' educational path. Regulations on occupational safety were significantly improved. New regulatory documents in operations included the Budgeting Policy, forms on disclosure of conflicts of interest.

Internal control and risk management

The internal control and risk management system is aimed at timely identification and analysis of the risks at all levels. The function is reported to the President and is in functional supervision of the Board of Trustees. The main regulatory framework is the Policy on internal control system and Regulations for conducting internal audits.

Activities included checks of functional directions and monitoring of targeted and effective spending of Skolkovo Grant. Skoltech received a positive opinion from the independent auditor on financial statements for 2022 (RAS and IFRS), and the Skolkovo Foundation opinion on target use of the Grant. The corrective action plan based on results of the Foundation's audit 2022 was fully implemented in 2023.

Brand development

Presence in media and key forums

Skoltech technology results and advanced competencies were widely reflected in the media and at key exhibitions and discussion platforms.

Several Skoltech developments were exhibited at events with participation of the President of the Russian Federation – 'Forum of Future Technologies' (demonstration of photonic integrated circuits), RSC Energia (demonstration of microsatellite models). The expanded program was presented at the Congress of Young Scientists in Sochi, which is a key event of the Decade of Science and Technology.

Skoltech role in the national technology agenda was appraised in speeches of the President of the Russian Federation. During the plenary session at the 'Russian Energy Week', the President noted efforts of Skoltech, VEB.RF and service companies to study investments in production of equipment for development of deposits, including hard-to-recover hydrocarbon reserves. At the 'AI Journey' conference, the President named Skoltech among top Russian universities for training experts in AI.

Wide presence was also ensured in a number of new flagship awards: Sber Science Award and Vyzov Award.

On discussion and media platforms, Skoltech was positioned as the intellectual hub for technology sector of the Russian economy. Faculty gave expert comments in sessions of St. Petersburg Economic Forum, while students' development of the Robotics Laboratory became the central attraction in the media agenda.

The geography of media mentioned Skoltech or turned to Skoltech expert opinion was expanded. Russian media was interested in topics of AI and results of application of computer vision for various fields. The interest of international media lied in research on effects of solar phenomena on many industries and technological systems in space and on the Earth. In addition to English-language materials in general media (Forbes, India Times), popular science

media (New Scientist, Scientific American, SciTechDaily) and specialized websites (Photonics.com, 3D printing industry, Phys.org), articles were published in Chinese (CGTN, etc.), Arabic (RT Arabic, etc.), French, Spanish, German, Iranian, Czech, Croatian and Romanian sources.

The technology of the startup 'Em Polymer', developed as a result of collaboration of a Skolkovo gymnasium student and Skoltech faculty, received a wide coverage in Russian media. The prototype was demonstrated at the Congress of Young Scientists as a case of successful collaboration of scientists of several generations within the same ecosystem.

Skoltech hosted more than 100 delegations, including ambassadors, representatives of Russian executive authorities, high-tech business.

Brand and marketing

Marketing and promotion was carried out mainly through social media and other online tools. Telegram channels showed 178% increase in subscribers, as well as efficiency in attracting applicants and target audiences to various events.

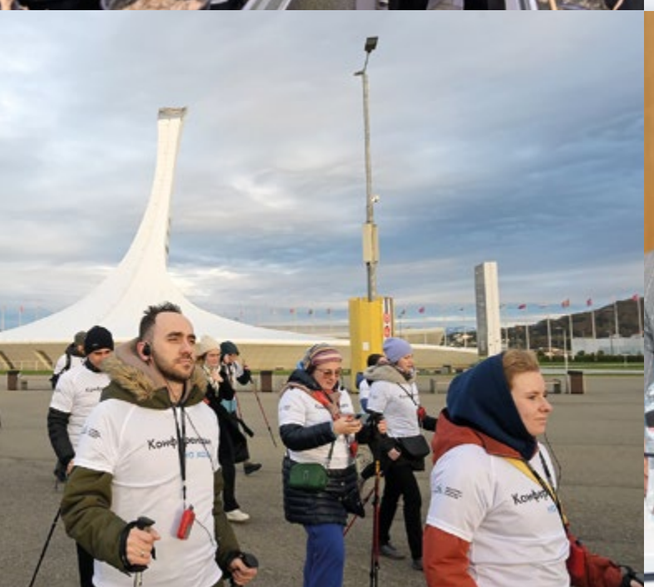
The audience of Zen blog grew by +2672%, which was made by generating attractive content, and active involvement of researchers in preparation of interesting materials. The 'Scientific Travel Guide' is also worth noting: the project highlighted 10 places in Russia worth visiting for those interested in science. The format of short vertical videos about education, science and events was actively developed (coverage more than 1.6 mln people).

Strong marketing support was provided on the admission campaign and community events.


Skoltech
Neuro


Skoltech


SPIEF'23
ПМЭФ'23




IT В ИЛЛЮМИНАТОР
ЦИФРОВИЗАЦИЯ КОСМИЧЕСКИХ МАСШТАБОВ

Outreach activities

Media projects

Skoltech creates popular science content by implementing programs for a wider audience.

Jointly with the Russian Science Foundation, a media project 'Life and Other Stories', which is a series of interviews with renowned scientists and experts in biomedicine was completed. The book was published and presented at Skoltech and International Book Fair of Non-Fiction Intellectual Literature. Interviews appeared in media (Kommersant-Nauka, STYmul, Naked Science, Biomolecule, Schrodinger's Cat magazine).

Within the Decade of Science and Technology in Russia, a project 'VR Kolmogorov', dedicated to the 120th anniversary of the birth of the great Soviet mathematician, was launched. The project included the exhibition on campus, Mathematical conference 'Kolmogorov-120', Kolmogorov Open Cup ski race and VR exhibition at the Congress of Young Scientists in Sochi.

Several media projects received external awards. The 'Mathematical Walks +' entered the top list of the non-fiction fair, and became the winner of the II Degree of the Russian Award 'For Dedication to Science'. The cover of 'Life and Other Stories' book entered the top list of the special exhibition 'Non-Fiction Cover'. The jury's choice.'

'Life and other stories' is a project about science and people who devoted their lives to science: a continuous search for new things, and struggle for excellence is a very exciting thing. Of course, the task of RSF and researchers whom we support is not only to achieve research results, but also tell colleagues and society about them. This is what the 'Life and other stories' is about. The RSF annually finances thousands of research teams, and we plan to further expand our support. I thank Skoltech scientists, many of whom received our grants, and I hope that their number will increase, and we will be proud of their success.

Alexander Khlunov, Director of the Russian Science Foundation


Открытый Кубок
А.Н. Колмогорова
Skoltech
Skoltech
Skoltech
1


РАЗГОВОРЫ
ЗА ЖИЗНЬ


лекторий
Сколтеха
WHAT?!

Wider community

Activities for wider community were focused on promoting Skoltech campus as the point of attraction for those interested in science and technology, as well as expansion of geography of events. The events gathered more than 8000 participants and around 5 million online views.

Skoltech conducted activities for talented children from almost all regions – more than 4000 schoolchildren from Norilsk, Chita, Murmansk, Zapolyarny, Snezhnogorsk, Tomsk, Smolensk, Ulyanovsk, Chelyabinsk, Yakutsk, took part in lectures, workshops, and excursions to Skoltech.

A new project 'What?!/Вот?!' kicked-off with a large summer festival, continued by 'A day-off with brain' and 'A day-off with light' in autumn.

Data Science Fest in Yekaterinburg, lectures in 'Hi, Tech' project were held in 10 cities of Russia.

Skoltech also conducted a wide program in Moscow. In addition to regular partners (Zaryadye, Gorky Park, Arhe), new collaborations were launched – Karo. Art, Moskino, ATOM Pavilion at VDNH. Skoltech participated in festivals 'Science 0+', 'VK Fest', 'World Science Day', 'Loud Voice of Science', 'Russian Science Day', 'Space Day' and 'DNA Day' in Zaryadye.

Collaborations in the ecosystem were advanced. The project course 'Innovatika', 'Day of Scientific Tasks' from PhD students, lectures by faculty, excursions and internships, meetings with students and graduates, and the Open Day were held for the Skolkovo Gymnasium. Partnership with Skolka School was underway.

Events

More than 250 events were organized on campus and outside during the year. Highlight events included the Conference on Superconductivity in Nanostructures, First National Conference on Computer Materials Science, Skoltech Birthday, exhibition 'VR Kolmogorov', 'What?!/ Вот?!' Festival, a presentation of the book 'Life and Other Stories'. The campus remained in demand for external events, with clients coming mainly from banking and oil and gas sectors.

Project management

The portfolio included more than 230 projects over 3 mln Rubles. The portfolio evolved showing a growth of large projects (increase in average cost by 10%), as well as focus on projects with TRL 5 and higher. New projects were launched, among those to highlight are the following:

- a project for development of technologies for production of electrode materials of metal-ion batteries, to further organize their production in Russia by 2030,
- a project on wastewater research for educational institutions (order from the Directorate for Ensuring the Activities of State Institutions of the Department of Education and Science of the City of Moscow),
- development of a serial mass spectrometer sample based on results of joint successful implementation of the project for creating a high-tech mass spectrometer complex jointly with MIPT,
- a project for providing expertise on world-class campus design in Novgorod Veliky.

Successful implementation of R&D projects in 2018 – 2023 and achievement of high TRL helped to significantly increase the IP income.

Regular monitoring of the portfolio was carried out in terms of TRL, ongoing activities and risks, which allowed to have a high % of works acceptance by contractors (98.7% of projects). Other activities included a restructuring of contractual support, reduce of sanctions risks, timely contracting of projects. The project management efficiency was ensured via creation of information space, trainings and mentoring program for managers, a unified system for recruitment of managers, and development of a portal of competencies.

Administrative services

Operational activities focused on ensuring financial and operational sustainability, implementing and maintaining high-quality, reliable and transparent processes, a customer-oriented approach in administrative services, and monitoring resource efficiency.

To improve efficiency of planning and use of funds, liquidity management and attraction of credit instruments, as well as financial and treasury policies were revised.

Key results of the legal support included renewal of Skoltech educational license, concluding agreements for BSc programs and policy making for autonomous award of academic degrees.

Key measures to ensure operational sustainability included:

- use of external platforms in addition to standard tools for purchases;
- docflow improvement: regulation of work with official information of limited circulation, transfer of contractors to e-docflow, systematization of archive;
- organization of the compliance in line with the legislation on personal data protection;
- inventory of fixed assets used for R&D activities;
- new salary projects, transition to a single tax payment.

In the IT, efforts were made to ensure information security, develop infrastructure and expand services:

- information security policy was issued, audit of security of Skoltech network resources was conducted, penetration testing was conducted;
- modernization of network equipment was carried out, material and technical base and a replacement fund of multimedia equipment have been created in the absence of support from foreign vendors, fault tolerance and stability of key IT services improved;
- corporate employee directory was improved.

3 //
Financial report

Message from Senior Vice President for Finance and Operations

This year Skoltech confirmed the reliability of the model, continuing to implement the chosen strategy. Despite geopolitical and economic turbulence, Skoltech achieved sustainable results, reaching the targets, and increasing the revenue by 13% compared to 2022.

We amended finance and treasury policies to reduce the impact of a high inflation on the Institute's expenses. These changes target more efficient planning and use of fund, liquidity management, and attracting credit instruments for implementation of projects and maintaining a long-term growth strategy.

To adapt and ensure operational sustainability, several measures were taken to effectively organize procurement in terms of external platforms. We also significantly improved the document management process and strengthened compliance in personal data protection to align with the legislation.

The planned audit of the Federal Treasury of the Ministry of Finance, as well as the audit of spending of subsidies for R&D in the scientific and technological field for the period from 2012 to 2023 were successfully completed. The results confirmed a high level of discipline in the financial policy.

Skoltech increased external funding by more than 10% compared to 2022, continuing to diversify sources of income. The growth of revenue is due to the sales of the IP for 4G/5G technology. Also, Skoltech started a new project within the national program of world level campuses.

The Institute constantly faces financial challenges in implementing external projects. In 2023, for the first time the credit line agreement for 200 million rubles was signed to ensure financial stability while project implementing. At the same time, a high cost of raising funds may influence future profitability of R&D contracts.

Skoltech continued the laboratory construction program. The completion of the main complex is planned for 2024. At the same time, implementation of the program may be affected by insufficient governmental funding, which, in turn, raises necessity to attract additional investments.

Reduction of the governmental funding remains a main financial challenge. To mitigate possible restrictions and support new initiatives, we started to form a reserve fund. Despite existing challenges, the Institute's net assets, which are a key indicator of resources, remain stable, ensuring a sustainable financial position.

I would like to thank all our partners and my colleagues for constant and valuable contribution to development of Skoltech as a leading institute in Russia and the world.

Sincerely,
Tatyana Zakharova,
Senior Vice President for Finance and Operations

Financial results

During the fiscal year of 2023, unstable economy and challenging political landscape, restrictions on state funding, weakening of Russian ruble, a rapidly raising refinancing rate, increasing cost pressure and restrictions on purchases, along with Skoltech commitment to complete the laboratory construction, continued to influence on financial activities and operations.

Skoltech ended the year, achieving the targets for attracted funding, ensuring financial framework that supported efficient use of resources. These included the issue and implementation of the Budget policy and financial strategy, a new treasury model for payments in foreign currency via international agents and banks, managing bank loans to finance projects, broadening a scope of new marketplaces and independent suppliers of foreign equipment and materials.

Skoltech has successfully passed the Federal Treasury audit for 2011 – 2023, and the audit of use of the subvention on research and development works in the scientific and technological sector for the period 2012 – 2023. Financial statements for the fiscal year 2022 have received an unqualified audit opinion.

Financial overview

The total funding, a growth of external income and efficient management of expenses made it possible to fulfill obligations set in the Strategy.

(in millions of rubles)	2016	2017	2018	2019	2020	2021	2022	2023
Total funding	6 438	6 539	7 026	8 313	8 984	10 224	11 042	11 177
Operating expenses	3 626	4 084	5 557	6 620	7 204	7 499	7 778	8 000
Capital expenses	2 215	1 794	689	800	1 083	806	874	857
Endowment net assets	4 556	4 717	4 559	4 775	4 787	4 634	4 929	4 821

Skoltech ended the fiscal year with a 10% increase of attracted funding, compared to 2022, received a high level of return on endowment and ensured sufficient resources to support research and education, and operations, continuing to invest in the infrastructure. The growth of attracted funding was driven by the IP sales (4G/5G).

At the same time, ensuring substantial funding for commercial projects remains on the agenda, since most of contracts suggest post payments and require investments to secure cash flows. To support these activities, Skoltech signed a loan agreement with Absolut Bank for a 200 mln. rubles credit line for project financing. However, increasing a cost of capital may deteriorate profitability of projects.

Skoltech also put efforts in diversification of external income. For example, in 2023 the contract for the project of 'World-class campus' was started.

The Institute ended the year with an operating surplus of 1.773 mln. rubles, or 18% from total funding for operating activities, compared to 1.449 mln. rubles in fiscal year 2022. The increased surplus was mainly supported by the sale of IP. The surplus, excluding the IP sale, resulted to 1.150 mln. rubles, that is lower than in fiscal 2022, and explained by investments made into Centers supply, services and staff, as well as a growth of campus maintenance costs and impact from the inflation growth.

The plan to migrate into the local ERP solution was rescheduled to 2024, this resulted to the remaining funding at the end of fiscal 2023 subject to carry forward to 2024.

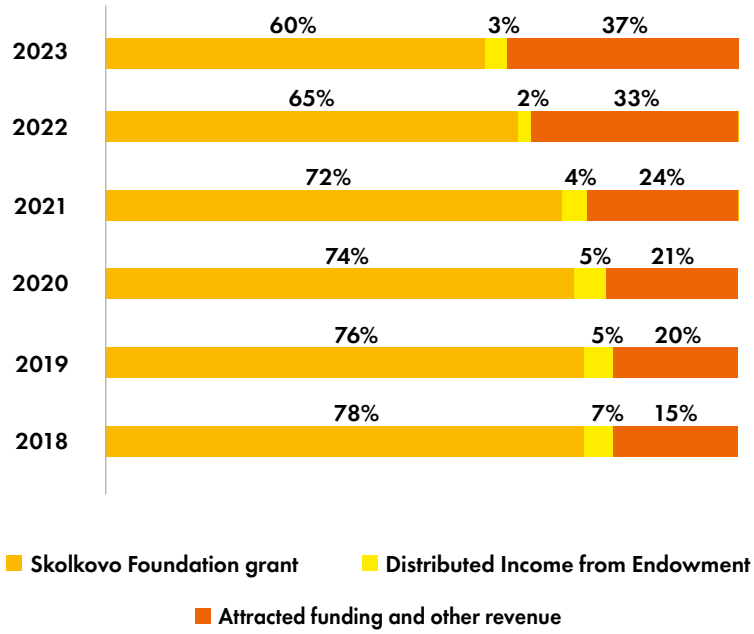
Funding

The funding structure includes the Skolkovo Foundation grant, which remains the primary source of funding, distributed income from endowment, attracted funding from contract and grants, and other sources of revenue.

(in millions of rubles)	2022	2023	Change %
Attracted funding, incl. other revenue	**2 973**	**3 347**	**13%**
Attracted funding	**2 755**	**3 051**	**11%**
Sponsored research contracts	1 317	2 281	25%
Grants	1 285	661	-49%
Professional education	121	62	-49%
Shared facilities	33	47	45%
Other revenue	**218**	**296**	**35%**

The total funding from the Skolkovo Foundation grant resulted to 6.683 mln. rubles, or 60% from total available funding, including carry forwarded balance from fiscal year 2022. Skoltech demonstrated a steady growing trend in attracted funding and other revenue in total funding structure.

Funding Structure



Total funding in fiscal year 2023 resulted to 11.177 mln. rubles. While the Skolkovo grant decreased 5%, the total funding remained at the level of fiscal year 2022, showing a modest growth of 1%, driven by revenues from contracts and grants increased by 11% and other revenue increased by 35%, compared to fiscal year 2022.

Attracted funding growth is mainly supported by the IP sale.

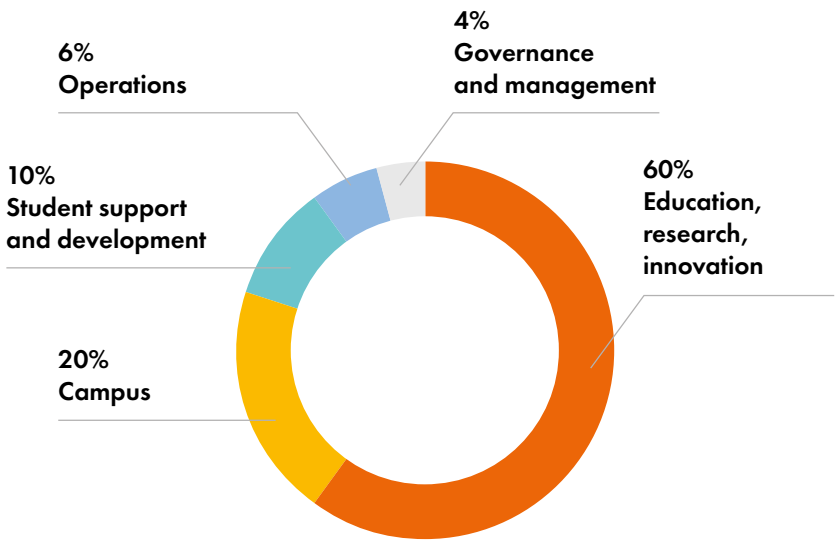
Other revenue totalled 295.616 k rubles and driven by managing cash reserve to increase rate of return on investments into financial instruments. In fiscal year 2023 Skoltech received income from financial instruments in the amount of 155.902 k rubles.

Income distributed from endowment totalled 380 mln. rubles, a 67% increase compared to fiscal year 2022. Due to effective investment strategy and a high return on the endowment in fiscal year 2022, compared to low return generated in fiscal year 2021, it made possible for Skoltech to distribute in 2023 more funding to support operating activities.

Consolidated expenses

Consolidated expenses resulted to 8,857 mln. rubles, including operating expenses totalled 8,000 mln rubles and capital expenses totalled 857 mln. rubles. The structure of expenses had no significant changes compared to fiscal year 2022.

Consolidated expenses per programs



Operating expenses

Expenditure comprises the following primary activities: teaching & learning, research, innovation, student support and development, operations, campus, governance and management.

Consolidated operating expenses increased by 222 mln. rubles, or 3% compared to fiscal year 2022, reflecting the increased number of contracts and grants. At the same time expenses from the Skolkovo grant stayed at the level of fiscal year 2022 showing around 1% growth.

Personnel related expenses totalled 4.751 mln. rubles, or 59% from the total operating expenses, compared to 4.695 mln. rubles, or 60% in fiscal year 2022, leading in the total structure of expenses. They mainly consisted of salaries, compulsory social security contributions, bonuses, medical insurance, reimbursement of accommodation and benefits in kind, PSA agreements, and research grant payments. Salaries and wages increased by 5% or 199 mln. rubles. This was due to the salary indexation, and recruitment of faculty and staff.

Campus rent, utilities and maintenance expenses resulted to 1.068 mln. rubles, or 13%, include costs to rent campus laboratory and office premises, costs for repair and maintenance of engineering systems in campus, utilities, cleaning of premises and territories, security and insurance services. A 2% growth of expenses is driven by the increased cost of maintenance, including fireproofing treatment of campus external wood panels.

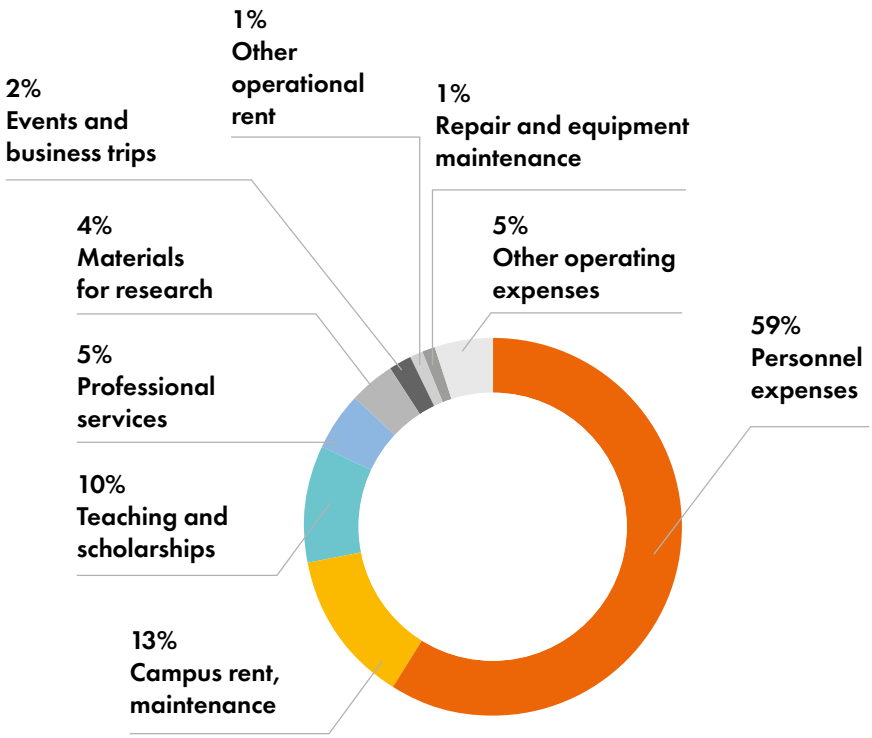
Teaching and scholarship expenses totalled 798.773 k rubles, or 10%. These expenses are represented by scholarships and medical insurance for students, outreach and recruitment program, expenses on guest lectors, student dormitory, academic mobility program and other compensations. A slight decrease of expenses by 1% compared to 808.650 k rubles in fiscal year 2022, was driven by efficient scholarship fund management.

Skoltech spent 314.236 k rubles, or 4% from total operating expenses, on materials for research, compared to 305.297 k rubles in fiscal year 2022.

Business trips and events totaled 200,053 k rubles, or 3%, and reached the level of fiscal year 2019 before the pandemic.

Professional services expenses increased by 7% compared to fiscal year 2022 and resulted to 368.665 k rubles, reflecting increased number of research contracts and grants. These expenses include professional services for research and development works under attracted contracts.

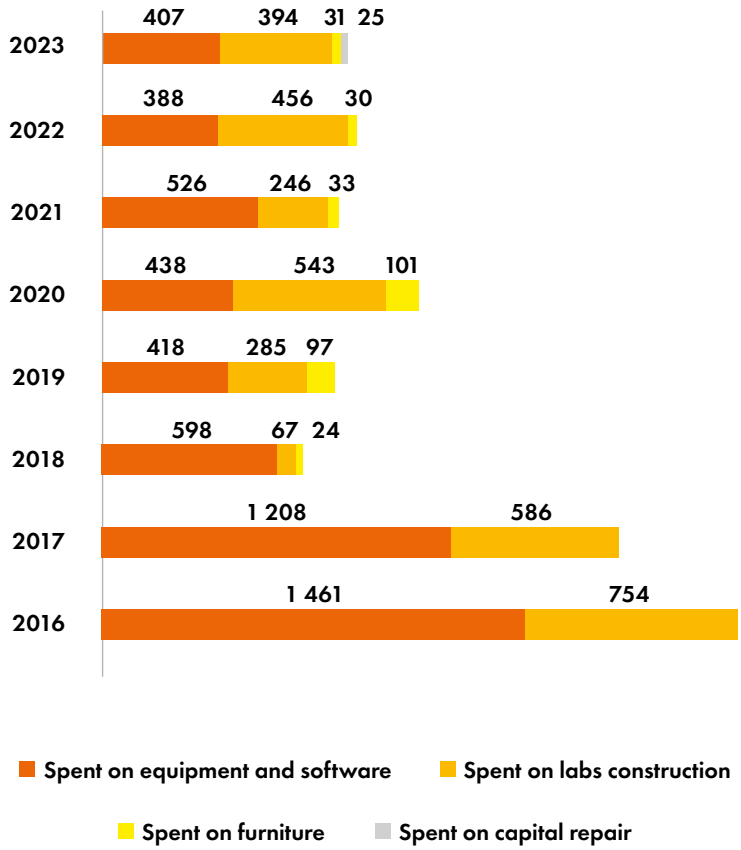
Operational expenses 2023 per categories



Laboratories construction and campus infrastructure

In accordance with the Strategy, Skoltech delivers the laboratory construction program. In fiscal year 2023 capital expenses totaled 857 mln. rubles, represented by expenses on equipment and SW (407 mln, rubles), expenses on laboratories construction (394 mln. rubles), furniture (31 mln. rubles) and expenses on capital repair (25 mln. rubles).

Consolidated capital expenses (mln. rubles)



In fiscal year 2023 the construction program and schedule were revised, due to supply chain disruptions followed by replacement of suppliers of the engineering equipment and related corrections of design solution of construction objects.

Endowment

The Endowment Fund was established to enhance Skoltech financial independence and support for implementation of the Strategy. The primary goal of the Endowment Fund investment policy is to ensure reliability, liquidity, yield and diversification of investments.

Endowment funds are managed by professional asset management companies: Management Company Alfa Capital and Management Company VTB Capital Asset Management. In accordance with the Investment Declaration approved by the Management Board of the Endowment Fund investments can be made into the state bonds of the Russian Federation, Russian corporate bonds and in Russian Rubles in state-owned banks. Targeted annual return on endowment is defined as 7%.

The Endowment net assets as of 31 December 2023 amounts to 4.822 mln. rubles compared to 4.929 mln. rubles as of 31 December 2022. The following assets comprise the portfolio of the Endowment Fund as of December 31, 2023.

Net assets	TOTAL mln. rub.	%
Russian government bonds	1 337	28%
Corporate bonds	2 891	60%
Cash and Cash Equivalents	593	12%
Other receivables/payables	1.7	0.04%
Total	**4 822**	**100%**

The return on the Endowment in fiscal year 2023 was 5.92%, or 276 mln. rubles, down by 4.23 percentage points from 458 mln. rubles at the end of fiscal year 2022.

Чистые активы	2022	2023	Change
Annual return from investment activities	458	276	– 182
Annual return %	10.15%	5.92%	– 4.23%

Tightening of monetary and credit policy of the Bank of Russia, inflation growth, weakening of Russian ruble and fiscal stimulus, raise of refinancing rate from 7.5% to 16% from the beginning of the year, significantly affected ruble bonds price in 2023. Conservative investment strategy helped to minimize negative impact on profitability of the endowment in fiscal year 2023. In aggregate, annual return for 2022 and 2023 resulted to 8%, comparing with lower bank deposit rates available at that span.

Current market level of percentage rates provides an opportunity to diversify into financial instruments with higher rate of return, such as bank deposits and bonds with long duration. Most part of current endowment portfolio is represented by bonds with minimum spread, or matured in the nearest future, which make it possible to perform diversification of investment portfolio with low risk, by demand. Investment portfolios mostly represented by bank deposits are less flexible for such diversification.

High interest rates on the bond and deposit markets provide an opportunity to increase current duration of Endowment investment portfolio, increasing share of deposits with the duration of from 1 to 3 years and bonds with duration up to 3 years.

In fiscal year 2023 distributed income from endowment was 380 mln. rubles. Actual expenses to support operating activities resulted to 329 mln. rubles, and noted below.

Actual expenses paid from distributed income from Endowment in 2023	%
Co-financing of research contracts	60%
Student support and development	14%
STRIP program and startups support	10%
PR and marketing	3%
Other expenses	13%

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