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Year in review

The institute was founded as an integral part of the Skolkovo ecosystem, its founders guided by the vision of creating a world-leading educational institute. As there have been multiple interpretations of this vision among stakeholders and management, over 2017 Skoltech was facing up the challenge of strategy alignment. As the result, the Strategic Action Plan 2018 – 2020 was approved by the Board of Trustees to focus Skoltech on six target domains and set key performance indicators to reflect the strategic goals of pursuing academic excellence and value generation.

In 2017, Skoltech invested significantly into developing its laboratory infrastructure. A dozen new laboratories were opened or substantially refitted. Temporary lab space grew to exceed 6,000 square meters overall. At present, as the relocation to the new campus has been extended to 2018, space becomes a limiting factor for further development.

Among the year's highlights was the opening of a state-of-the-art Enhanced Oil Recovery Lab created in partnership with the University of Calgary (Canada) to develop new solutions for production of conventional and unconventional resources. With the assistance of these advanced facilities, the new laboratory's research performance has exceeded expectations and is on par with leading peers around the globe. This has been confirmed by the lab's entry commercial contracts with such industry giants as Gazprom Neft, Total and Schlumberger.

Upwards of 100 representatives of Russian and international industry visited Skoltech for the opening of the Additive Manufacturing Lab. Home to a globally unrivaled collection of the latest 3D printing technologies, the lab will collaborate with Oerlikon (Switzerland) and the Technical University of Munich (Germany) to bolster its technological offerings in Russia and abroad.

Skoltech's research profile has continued to grow swiftly and the institute has gained international recognition for its top-notch quality. Compared to the previous year, 2017 saw a surge in sponsored research funding, a 29% boost in funds from industry and a two-fold increase in domestic and international grants. Among the year's highlights were research

projects funded by ISS Reshetnev, Huawei and Gazprom Neft R&D, as well as a mega grant for establishment of a new laboratory that will focus on tensor networks and deep learning for applications in data mining.

Seven Skoltech faculty projects were selected for support within the Skoltech Translational Research and Innovation Program. These projects focus on addressing a variety of modern problems, such as creation of materials for redox batteries, a robotic platform for warehouse automation, a platform for flexible online electronics, a portable wireless electrocardiogram device, a new type of marker for virtual reality systems, devices for ultrasonic applications and hydrocarbon field exploration technologies.

Similar to 2016, faculty publication activity (i.e., the average number of published papers per professor) remained on par with the world's leading young universities, such as KAIST (Korea), HKUST (Hong Kong) and NUS (Singapore). In addition, Skoltech's Web of Science citation score soared in 2017, resulting in receipt of the Rising Star of Citation Impact award. In the prestigious Nature Index, despite its small size, Skoltech was ranked third in Russia in the Nature & Science journal group following the Russian Academy of Sciences and Moscow State University.

In 2017, Skoltech focused on transforming student learning experiences by launching a new portfolio of MSc and PhD programs and implementing practices aimed at meeting unique educational needs of centennials (digital natives), such as through learning-by-doing and learning-by-teaching opportunities. In addition to rapid expansion of its local course offerings, Skoltech supported student mobility in a major way: more than 40% of students received support, with approximately one-third opting for domestic mobility trips of various terms, and two-thirds traveling internationally.

The caliber of Skoltech's newly admitted students in 2017 – including 20% international students – attested to the strength of the institute's educational program. Against the backdrop of a fiercely competitive admissions process, Skoltech received some 11,000 applications from 123 countries; the admission ratio for MSc

programs reached 100:1 (international students) and 35:1 (Russian students). For PhD programs, those figures reached 130:1 (international students) and 31:1 (Russian students). About 50% of the 2017 intake included students who had graduated from universities in the top 300 QS Ranking, while others appeared to be ambitious recent graduates from towns across Russia.

As a reflection of Skoltech's innovation-oriented education, students successfully participated in domestic and international competitions. Among many other honors, students from the Center for Computational and Data-Intensive Science and Engineering won a prize at a Kaspersky Lab hackathon and placed third at the Data Science Game in Paris, where 340 teams from 40 different countries battled for excellence. Being the only Russian team in the final of the world championship Eurobot Open 2017, the ReSet robotic team took the prestigious 5th place – seven positions higher than its 2016 results. Meanwhile, PhD students of the Center for Hydrocarbon Recovery won the best performance prize at the final of the European stage of the Imperial Barrel Award Competition 2017, an annual competition for geoscience graduate students from international universities.

Highly remarkable was the graduation of the first class of PhD students. 100% of PhD students successfully completed their studies. 87% defended their dissertations in the fields of Life Sciences, Engineering Systems and Computational and Data Science and Engineering and received state diplomas, having passed Skoltech's PhD defense procedure, which was conducted in accordance with international practices in front of juries that included faculty from the Massachusetts Institute of Technology, Delft University, Imperial College of London, Tel Aviv University, University of Illinois. The percent of PhD degrees conferred is significantly higher than in many leading Russian universities.

In 2017, Skoltech also launched programs to reach out the wider community and, in particular, youth in schools to highlight what university life can offer and to encourage their future participation. A special focus was placed on collaboration with the

Skolkovo International Gymnasium and Sirius Educational Center in Sochi: Skoltech professors and students gave dozens of lectures and seminars, as well as hosted schoolchildren at Skoltech labs. A pilot summer school for gifted undergraduates exposed the participants to advanced research by providing opportunities to work with leading scholars from Skoltech, as well as its Russian and international partners.

Skoltech significantly broadened its engagement with the ecosystem of the Skolkovo Innovation Center: 45 faculty and researchers relocated to the Professors' Quarter and Tetriz apartments. I expect, more will relocate in 2018.

Very recently, Professor Dmitri Papatsenko passed away after a long and heroic battle with cancer. Dmitry had been in Skoltech since 2015, conducting research and teaching courses in Stem Cell Biology and Developmental Biology, and combining the expertise in biology with his self-taught mathematical skills. He was a man of big personality. This is irreparable loss for our Institute.

The Annual Report provides a comprehensive overview of institutional achievements in line with the commitments to excellence and linking research with industry, the economy and society.



A stylized, handwritten signature in blue ink, which appears to read 'A. Kuleshov'.

Alexander Kuleshov
Skoltech President

BOARD OF TRUSTEES

The Board of Trustees of the Autonomous Non-Profit Organization “Skolkovo Institute of Science and Technology”

CAS

Center for Advanced Studies

CDIBB

Center for Data-Intensive Biomedicine and Biotechnology

CDISE

Center for Computational and Data-Intensive Science and Engineering

CDMM

Center for Design, Manufacturing and Materials

CEE

Center for Electrochemical Energy Storage

CEI

Center for Entrepreneurship and Innovation

CES

Center for Energy Systems

CHR

Center for Hydrocarbon Recovery

CPQM

Center for Photonics and Quantum Materials

CREI

Center for Research, Education, Innovation

CTB

Center for Translational Biomedicine

ECTS

European Credit Transfer and Accumulation System

FTE

Full-time equivalent

IAC

International Advisory Committee

KPI

Key Performance Indicator of the development of the Institute

MIT

Massachusetts Institute of Technology

MRA

Master Research Agreement

NGP

“Next Generation Program: Skoltech-MIT Joint Projects”

NTI

National Technology Initiative

PI

Principal Investigator

RFBR

Russian Foundation for Basic Research

RSF

Russian Science Foundation

SBI

Skoltech Biomedical Initiative

SC

Space Center

SEH

Skolkovo Educational Hub (Moscow School of Management, Skoltech, New Economic School)

SKOLKOVO FOUNDATION

Non-Commercial Organization “Foundation for the Development of the Center for the Elaboration and Commercialization of New Technologies” (Skolkovo Foundation)

SKOLTECH, INSTITUTE

Autonomous Non-Profit Organization for Higher Education “Skolkovo Institute of Science and Technology”

STRATEGIC ACTION PLAN (SAP)

Skoltech Strategic Action Plan 2018-2020, which describes the Institute’s vision, strategic goals and initiatives, key tasks and actions, targeted Key Performance Indicators and persons responsible for their achievement, budget and risk analysis (approved by the Board of Trustees, Minutes No. 27, dated 13 December 2017).

TARGET DOMAIN

Strategic focus areas aimed at reaching academic and brand excellence and forming a foundation for value generation; established in the SAP based on technological priorities and experience

WoS

Web of Science database

Focus and Governance

/01

Key Performance Indicators

KEY PERFORMANCE INDICATORS*	2015	2016	2017
ACADEMIC EXCELLENCE			
FACULTY	60	86	104
POSTDOCS & RESEARCHERS	74	112	184
PUBLICATIONS (I.E., INDEXED IN WOS, SCOPUS) PER FACULTY MEMBER	2,5	4,4	5,6
PUBLICATIONS WITH INDUSTRY IMPACT PER FACULTY MEMBER	0,31	0,88	1,41
KNOWLEDGE EXCHANGE WITH INDUSTRY (DAYS/FACULTY)	14	17	36
STUDENTS (MSC & PHD)	315	481	706
EDUCATIONAL PROGRAMS (MSC & PHD)	6	15	17
INNOVATION PROGRAMS	2	4	3
GRADUATES	51	81	92
% OF GRADUATES INVOLVED IN INNOVATION ACTIVITIES	51	67	67
VALUE GENERATION			
ATTRACTED FUNDING (MLN.RUB)**1	265	348	554,7
NEW ENTERPRISES (INCL. RESIDENTS OF SKOLKOVO) (CUMULATIVE)	7	10	14
PATENT APPLICATIONS PER FACULTY MEMBER	–	–	0,2
NEW EFFECTIVE PRACTICES FOR RUSSIAN UNIVERSITIES	2	1	1
* KPIs as indicated in the Grant Agreement with the Skolkovo Foundation			
**			
Grants (mln.RUB)	65	69,5	122,8
Professional training (mln.RUB)	–	–	4,8
Industry funded research (mln.RUB)	200	278,5	427,1
% of External funding to total expenses (excl. Campus)	15%	15%	20%

¹ Calculated as cash received.

KPIs ANNOTATION

FACULTY faculty with (i) long-term (over one year) employment agreements with at least 20% working time or (ii) candidates for faculty positions with signed offers for such arrangements; the indicator is calculated as of the end of the calendar year	contracts, conferences etc.) to the average number of faculty during the reporting period	abovementioned organizations; or (iv) continue at Skoltech to complete PhD programs (MSc graduates), from the total number of MSc and PhD graduates during the reporting period; this indicator is calculated based on alumni surveys
POSTDOCS & RESEARCHERS research staff (excl. faculty) having employment agreements as of the end of the calendar year	STUDENTS (MSc & PhD) total number of MSc and PhD students as of the end of the calendar year	EDUCATIONAL PROGRAMS (MSC & PHD) total number of MSc and PhD programs as of the end of the calendar year
PUBLICATIONS (I.E., INDEXED IN WOS, SCOPUS) PER FACULTY MEMBER² ratio of faculty publications affiliated with Skoltech, indexed in WoS and/or Scopus, to the average number of faculty during the reporting period	INNOVATION PROGRAMS total number of innovation-oriented courses (educational programs), research programs in the field of innovation, entrepreneurship programs as of the end of the calendar year	ATTRACTED FUNDING income from external sources (excl. Skolkovo Foundation grant) to the total amount of Institute expenses during the reporting year
PUBLICATIONS WITH INDUSTRY IMPACT ratio of faculty publications affiliated with Skoltech on topics relevant to industry, or in co-authorship with industry representatives, to the average number of faculty during the reporting period	GRADUATES total number of students that graduated from MSc and PhD programs during the reporting year	NEW ENTERPRISES (INCL. RESIDENTS OF SKOLKOVO) companies established by Skoltech faculty, researchers, students
KNOWLEDGE EXCHANGE WITH INDUSTRY total number of days spent by each faculty member (on average) on collaborating with industry (industry funded	% OF GRADUATES INVOLVED IN INNOVATION ACTIVITIES % of MSc and PhD graduates who (i) are employed in industrial or research organizations in Russia, (ii) have established startups or are employed in the Skolkovo companies, (iii) are doing internships in the	PATENT APPLICATIONS PER FACULTY MEMBER ratio of total number of Skoltech patent applications to the average number of faculty during the reporting period
		NEW EFFECTIVE PRACTICES FOR RUSSIAN UNIVERSITIES total number of international practices of research and educational activities disseminated to Russian universities

² The methodology refers to the KPI calculation in 2017.

Institutional Development

EXPERT REVIEW OF THE CREIs

The Skoltech leadership initiated an expert review of the Institute's eight CREIs³ for two purposes: (i) to address the IAC's recommendation to review the CREI portfolio, focus on fewer areas and achieve a critical mass of full-time faculty, which, in turn, would help the Institute to stand out among its competitors⁴ and (ii) to form a basis for revising the Strategy of Development.

The evaluation framework focused primarily on research performance, education and innovation activities, and the potential of academic

staff, partnerships and research infrastructure (presented and discussed at the meeting of the Academic Council, September 2016).

The procedure was organized in the form of an external international review; the pool of experts included 67 representatives of leading universities, research centers, laboratories and industrial companies from Europe, the United States, Russia, Australia and Israel. The expertise was arranged within five key areas, defined in accordance with Skoltech research portfolio.

Table 1. Areas of expertise

N	AREA OF EXPERTISE	COORDINATOR OF EXPERT REVIEW (COORDINATOR)	CREI(s) REVIEWED
1	Materials science, electrochemical energy conversion	Michael Levi, Associate Professor, Bar-Ilan University	CEE
2	Electrical and electromechanical engineering, optimization and control	Elena Lomonova, Professor, Eindhoven University of Technology	CES, SC
3	Micromechanics, mechanics of composites and porous media, geomechanics and hydraulic fracture	Mark Kachanov, Professor, Tufts University	CDMM, CHR
4	Optics, physics of condensed matter, and applied physics	Teun Klapwijk, Professor, TU Delft	CPQM
5	Biology and medicine	Fazly Ataullakhanov, Professor, Moscow State University, Dmitry Rogachev National Research Center	CDIBB, CTB

The review was executed in two stages:

- The analysis of materials, including the CREIs' initial development plans, completed and ongoing research projects as presented by CREI Directors, profiles of academic staff, publications, information

on academic and industrial partners, educational courses, research equipment (September-December 2016),

- Site visits and panel sessions with CREI Directors, faculty, senior researchers, postdocs and PhD students (January-February, 2017).

Upon completion of the project, the coordinators and external experts submitted assessment reports on research performance (scale of results, quality of publications, etc.), education and innovation activities, and provided recommendations with respect to priorities for development and prospective partners.

In addition, the coordinators provided the following institution-wide recommendations to Skoltech senior management:

- CREI programs should be substantially revised and more focused; some programs require reorganization;
- An external review of the CREIs should be conducted on a regular basis;

- The following areas should be considered as having strong potential for attracting a critical mass of faculty: Life Sciences and Health, High Tech Systems and Materials and Energy;
- The Institutional organizational structure should comprise a combination of Departments and CREIs.

The results of the expert review were presented to the Academic Council (16 February 2017), the IAC (8-9 March 2017) and the Board of Trustees (26 March 2017).

In accordance with the SAP, reviews of the CREIs will be conducted in 2018 and 2020, taking into consideration the recommendations of the Academic Council and the IAC with respect to improving the evaluation procedure.

STRATEGY UPDATE

In 2017, Skoltech senior management launched a planning process which resulted in updating the institute's strategic goals as well as a comprehensive review of the KPIs. The SAP planning process included comprehensive consultations with the IAC, the Board of Trustees, the Academic Council, the leadership of international peer institutions⁵ and international consulting companies. The recommendations considered during the SAP preparation included:

- **IAC** (8-9 March 2017): implementation of the University 3.0 concept, maintaining cutting-edge research with consideration of use; stratification of areas of excellence to align with both global and national priorities; structuring the Strategy with respect to initiatives, activity plans and appropriate quantitative KPIs;

- **Board of Trustees** (27 September 2017): importance of Skoltech international positioning; endowment growth; setting mechanisms for recruiting talented students; defining Skoltech advisory function; risk management; reflecting the humanitarian aspect of academic culture;

- **Academic Council** (14 September 2017, 8 December 2017): reinforcing mechanisms to attract high profile academic staff; the importance of being a student-oriented university; the necessity of defining ways to strengthen students' entrepreneurial skills; emphasizing Skoltech impact on the Russian economy, technological agenda and society;

- **Leadership of peer institutions** – managing stakeholders' expectations in terms of setting up a common vision

³ CAS and CDISE were not evaluated due to their relatively recent establishment and the appointment of new CREI Directors.

⁴ "Review Report of the International Advisory Committee of the Skolkovo Institute of Science and Technology, 26-28 October 2015" (Section 2).

⁵ Discussions held with the leadership of KAIST, Postech, Technion, Weizmann Institute, University of Minho, MIT-Portugal Initiative, Cyprus Institute.

and realistic KPIs, diversification of international collaborations, deeper integration into national scientific and higher education landscape through proactive cooperation with Russian academic institutions and universities;

- **Consulting companies** – intensifying work with alumni also in terms of graduates' placement, importance of industrial contracts and endowment growth; necessity of benchmarking the Institute's results with leading young peer universities.

The SAP determines five strategic goals:

1. **Focus & Governance:** ensure the Institute's focus on vision and strategic plan monitoring and evaluation, shared governance and involvement of stakeholders.
2. **Academic Excellence:** perform cutting-edge basic and applied research, educate the next generation of science, technology and business leaders.
3. **Value Generation:** based on the Institute's academic excellence and unique research facilities create business opportunities in the form of professional education, advisory services, centers of collective use services, industry-funded research and results implementation, technology licensing, new enterprises established by faculty, students and alumni, also in collaboration with the Skolkovo Foundation.

4. **Cooperation:** being a part of the Skolkovo ecosystem, strengthen academic and industrial network, build global cooperation programs and an alumni network, serve and strengthen engagement with the wider community.

5. **Campus:** design, deliver and bring into operation best-in-class space, facilities and infrastructure that enable the Institute's vision.

In accordance with the SAP, the following Target Domains have been established based on technology priorities and experience:

- Data Science & Artificial Intelligence,
- Life Sciences & Biomedicine;
- Cutting-edge Engineering & Advanced Materials,
- Energy Efficiency,
- Quantum Technology,
- Advanced Studies.

Each domain serves as a lever for Institutional academic and brand excellence as well as forming a foundation for value generation. This foundation comprises the fields that have been and continue to be strong in Russia, i.e., Mathematics and Physics. This solid foundation is shored up with fields that will be of high importance for the future, and where Skoltech aims to be an international leader and a continuing source of future leaders for the Skolkovo community, Russia and the world (Fig. 1).

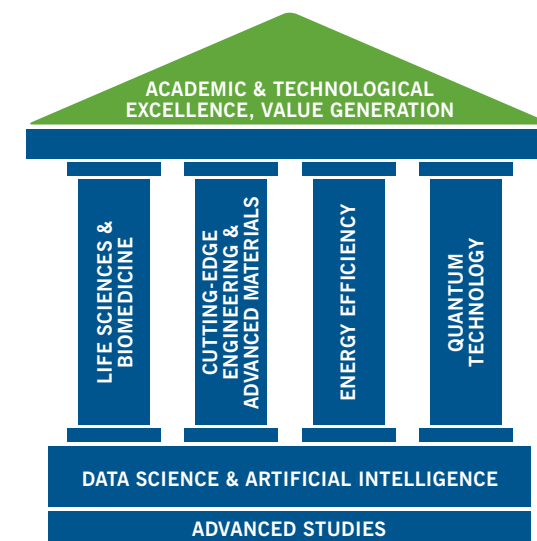


Figure 1. The chart shows the integration of Skoltech centers and programs. The foundation is based on Russian core strengths, but provides nucleation of key emerging areas of strategic growth and development.

In addition, the SAP establishes eight strategic initiatives, specific tasks and actions, and strategic and operational KPIs for measuring progress and performance. The SAP has been considered and

endorsed by the Board of Trustees (13 December 2017). As the next step, a comprehensive system of Institutional planning, monitoring and reporting on progress will be established.

ORGANIZATIONAL CHART

The Institute's organizational chart (Fig. 2) specifies key functional blocks established in accordance with the SAP priorities: Institutional Development, Academic Excellence, Value Generation, Campus and Administrative Support (Back Office). The chart also indicates the senior management responsible for operational

activities and reaching KPIs as well as the Target Domains established in the SAP in accordance with technology priorities and experience. Each Domain is represented by the corresponding CREIs and is a lever for the Institute's academic and brand excellence as well as a foundation for value generation⁶.

⁶ The planned contribution of the CREIs to the strategic KPIs is indicated in the SAP.

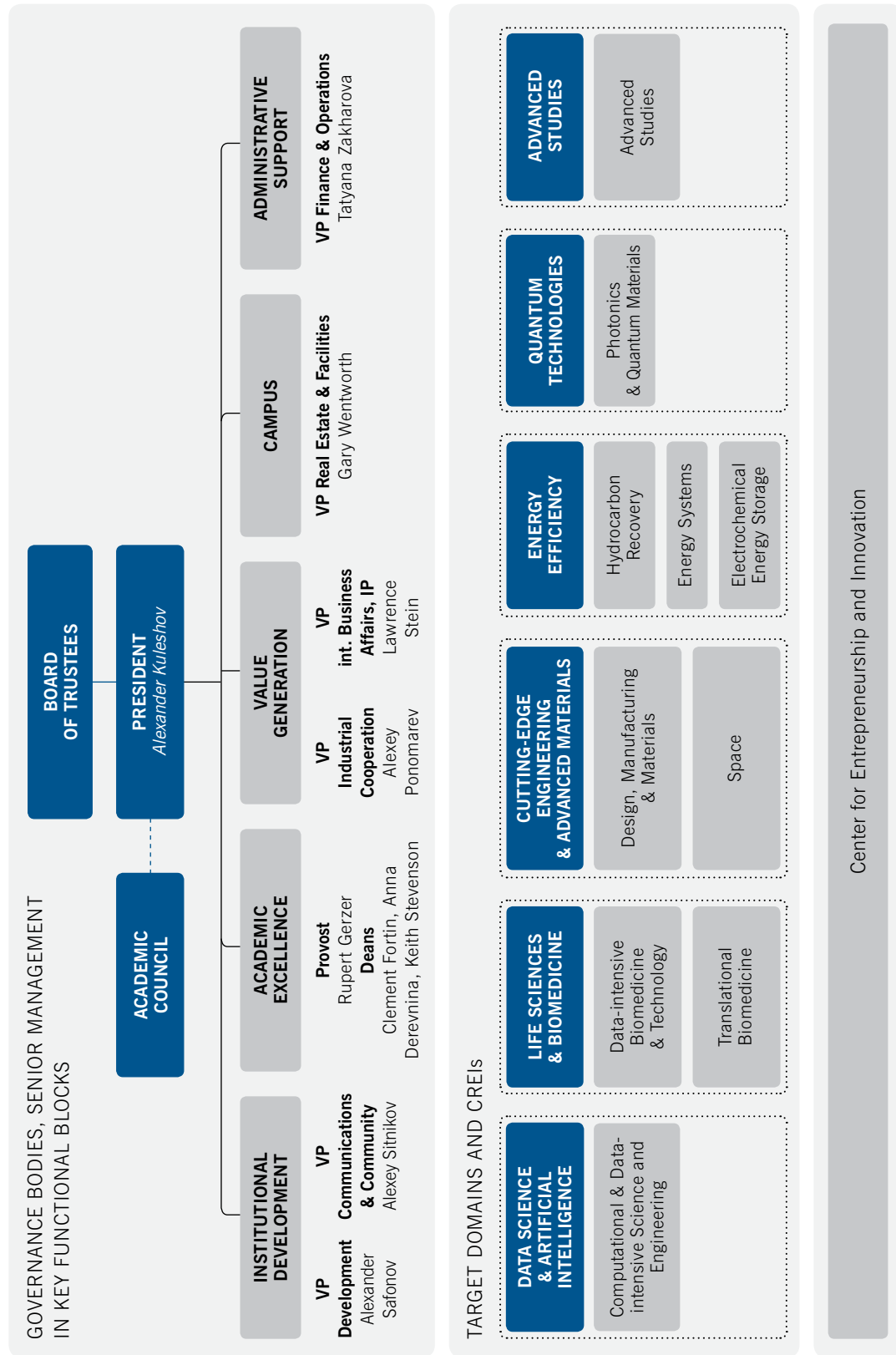


Figure 2. Organizational chart

Academic Council

ACADEMIC COUNCIL

In 2017, the Academic Council consisted of 19 members, including 12 members of the Skoltech faculty and administration, as well as seven external members. In September, Prof. Galina Tsirlina (Lomonosov Moscow State University) terminated her membership for personal reasons.

Academic Council membership (as of December 2017)

					
Prof. Alexander Kuleshov , Chairman, President, Skoltech	Prof. Rupert Gerzer , <i>Deputy Chairman, Provost, Skoltech</i>	Dr. Alexander Safonov , <i>Academic Secretary, Vice President for Development, Skoltech</i>	Prof. Iskander Akhatov , <i>Director, CDMM, Skoltech</i>	Dr. Jean Botti , <i>CEO, VoltAero SAS</i>	Prof. Alexey Buchachenko , <i>CEE, Skoltech</i>
					
Prof. Edward Crawley , Skoltech Founding President, MIT	Dr. Alexander Fertman , Director on Science and Education, Skolkovo Foundation	Prof. Boris Fine , CPQM, Skoltech	Prof. Clement Fortin , <i>Dean of Faculty and Postdoctoral Affairs, SC, Skoltech</i>	Prof. Ildar Gabitov , CPQM, Skoltech	Prof. Grigoriy Kabatiansky , Advisor to the President for Science, Skoltech
					
Prof. Nikolay Kudryavtsev , Rector, Moscow Institute of Physics and Technology	Prof. Artem Oganov , CEE, Skoltech	Prof. Andrei Okounkov , Columbia University	Prof. Pavel Pevzner , University of California, San Diego	Prof. Valery Rubakov , Moscow State University, Russian Academy of Sciences	Prof. Keith Stevenson , Dean of Research, Director of CEE and CES, Skoltech

During the year the Academic Council held four meetings. Issues of particular importance included:

- **Strategy of Skoltech Development** (recommendations for defining measures for retaining the best students, intensifying industrial collaborations, extending double degree programs to international universities, tracking the academic paths of PhD students, establishing limits for the number of PhD students per professor; and intensifying faculty outreach services),

- **Skoltech Strategic Action Plan 2018-2020** (recommendations for setting a strategy for attracting the best faculty and researchers, managing stakeholders' expectations and decreasing the proposed targets of the strategic KPIs, intensifying work with alumni, specifying operational KPIs for technology licensing).

Also, the Academic Council addressed the evaluation of the CREIs, reviewed the proposal for launching a BSc Program in Physics, established principles for formation of its Committees and carried out the planned rotation of their members.

ACADEMIC COUNCIL COMMITTEES

The Committees continued performing their duties in accordance with the Regulations on the Academic Council; as a rule, the meetings were held on a monthly basis.

Appointment, Promotion and Tenure Committee

Chair	Prof. Igor Krichever , <i>Director of CAS</i>
Members:	Prof. Iskander Akhatov , <i>Director of CDMM</i> Prof. Maxim Fedorov , <i>Director of CDISE</i> Dr. Alexander Fertman , <i>Director on Science and Education, Skolkovo Foundation</i> Prof. Clement Fortin , <i>Associate Provost, Dean of Faculty and Postdoctoral Affairs, SC</i> Prof. Ildar Gabitov , <i>CPQM</i> Prof. Yury Kotelevtsev , <i>CTB</i> Prof. Albert Nasibulin , <i>CPQM</i> Prof. Konstantin Severinov , <i>Director of CDIBB</i> Prof. Keith Stevenson , <i>Associate Provost, Dean of Research, Director of CEE and CES</i>
Meetings	Regular – 9, absentee – 2
Resolutions	<ul style="list-style-type: none">• faculty hiring decisions (16 positive, 67 negative resolutions);• faculty contracts renewals (7 positive resolutions)• faculty promotion (1 negative resolution);• promotion of research scientists to assistant/associate professor (4 positive, 2 negative resolutions);• nominations of faculty and researchers for scientific awards and scholarships (10 resolutions);• approval of the compositions of the Expert Groups;• approval of Policy on the Procedure for Appointment, Promotion and Tenure;• approval of Faculty Promotion Procedure.

Committee on Research Programs and Projects

Chair	Prof. Artem Abakumov , <i>CEE</i>
Members:	Prof. Georgii Bazykin , <i>CDIBB</i> Prof. Aldo Bischi , <i>CES</i> Dr. Alexander Fertman , <i>Director on Science and Education, Skolkovo Foundation</i> Prof. Anton Ivanov , <i>Director of SC</i> Dr. Dmitry Katalevsky , <i>Director of Department for Industrial Programs</i> Prof. Yury Kotelevtsev , <i>CTB</i> Dr. Dmitry Lakontsev , <i>CDISE</i> Prof. Andrei Osiptsov , <i>CHR</i> Prof. Arkady Shipulin , <i>CPQM</i> Dr. Nikolay Suetin , <i>Vice President on Science and Education, Skolkovo Foundation</i> Prof. Ighor Uzhinsky , <i>CDMM</i>

Meetings	Regular – 15, absentee – 6
Resolutions	<ul style="list-style-type: none">• purchases of research equipment (11 positive, 2 negative resolutions);• recommendations based on the results of the review of the CREIs;• approval of the procedure on evaluating research partnership agreements;• review of interim reports on active research grants and projects (14 positive resolutions);• review of scope of work on the MRAs (19 positive resolutions);• review of interim reports on the MRAs (16 positive resolutions);• review of new research initiatives and projects (9 cases considered).

Educational Committee

Chair	Prof. Maxim Fedorov , <i>Director of CDISE</i>
Members:	Prof. Alexei Buchachenko , <i>CEE</i> Prof. Alexei Cheremisin , <i>CHR</i> Prof. Michael Chertkov , <i>CES</i> Prof. Clement Fortin , <i>Associate Provost, Dean of Faculty and Postdoctoral Affairs, SC</i> Prof. Mikhail Gelfand , <i>CDIBB</i> Prof. Anton Ivanov , <i>Director of SC</i> Prof. Andrei Marshakov , <i>CAS</i> Prof. Oleg Vasilyev , <i>CDMM</i> Prof. Kelvin Willoughby , <i>CEI</i> Prof. Timofei Zatsepin , <i>CTB</i> Prof. Andriy Zhugayevych , <i>CEE</i>
Meetings	Regular – 6, absentee – 0
Resolutions	<ul style="list-style-type: none">• approval of MSc/PhD educational program portfolio and admission plan for the AY 2018-2019;• approval of the principles for invited lecturers' remuneration;• recommendations on the Library development plan;• approval of the mechanism for PhD students' scholarships rate revision;• approval of the list of candidates for the Chairs of the Federal State Attestation Committees;• recommendations for the student industrial immersion program.

Academic Excellence

/02

Research

During the first phase of establishing and fostering Skoltech highly competitive research strategy (2011-2015), an international competition was conducted to define strategic emerging research areas expected to have high technological importance and an impact both on Russia and the world. The leadership originally planned to determine 15 such research areas, each of which would nucleate the CREIs.

Based on the results of an evaluation conducted by the IAC in 2015, and taking into account various economic and political factors, the leadership decided to reduce the number of research areas in order to concentrate its resources and achieve a critical mass of full-time faculty in these areas. This, in turn, would enable Skoltech to stand out among its competitors.

During the second phase of Skoltech development (2016-2017), the leadership further decided to leverage fields which are traditionally strong in Russia, i.e., Mathematics and Physics. For this purpose, the Center for Advanced Studies was formed, and a team of internationally leading mathematicians and physicists were hired. Collaborations with leading universities in this area were also established. In addition, the Center for Computational and Data-Intensive Science and Engineering (CDISE) was strategically expanded and is now the fastest growing CREI at Skoltech. The

concept is to use the CDISE as the basis to integrate the fields of science that will be very important for future growth.

Skoltech CREIs, having specific research focus areas (see Section “Target Domains”), are incorporated into the Target Domains to support the execution of established institutional goals.

In the upcoming phase of Skoltech development, a further step will be introduced. Skoltech will refine strategic areas of growth and development, adopt and adapt to more interdisciplinary approaches and move into new emerging areas of breakout technologies. The new research programs will be designed in a way to involve most or all the CREIs as well as leading international collaborators, including MIT.

As the pilot approach Skoltech launched the NGP Program, which complements Phase II of its collaboration with MIT, as well as the Biomedical Initiative. In addition, in December 2017, the Research Initiatives Office arranged a Call for ideas to identify a few emerging breakthrough research topics that can be developed into multidisciplinary programs with a team-based format (e.g. network programs, research-driven collaborative projects, etc.). Within the Call, 13 proposals were submitted by Skoltech faculty and researchers. These proposals will be reviewed and discussed to identify up to three areas for the new Call for Proposals (planned for 2018).

industrial equipment and IoT technologies was completed. In addition, Masterskaya started working with the Navigator Campus on production of industrial prototypes. The facilities were also used by several startup companies, including Tsuru, Tardis, and Morphing Technologies.

In 2018, three major shared facilities will be operationalized: the Advanced Mass Spectrometry Facility, the Advanced Imaging Facility and the Advanced Genomics Facility.

The table and chart below present the current research infrastructure as well as facilities planning in new campus (East Ring).

Table 2. Skoltech research infrastructure

TARGET DOMAIN	LABORATORY	STATUS (LOCATION)
Data Science & Artificial Intelligence	Internet-of-Things laboratory (CDISE)	operational (TPOC-4), also planned in East Ring
	Soil Informatics laboratory (CDISE)	operational (TPOC-4), also planned in East Ring
	Tensor Networks and Deep learning for application in data-mining laboratory (CDISE)	operational (TPOC-4), also planned in East Ring
	Laboratory for 4D analysis (CDISE)	operational (TPOC-4), also planned in East Ring
	Comparative OMICS lab (CoBrain project) (CDISE)	operational (TPOC-4), also planned in East Ring
	Joint Lab Skoltech – Dokuchaev Soil Science Institute (CDISE)	operational (Dokuchaev Soil Institute)
	Research Center “Neurostream” (CDISE)	operational (Research Center of Neurology)
	Wireless Sensing Lab (CDISE)	in planning (East Ring)
	HPC & Big Data Lab (CDISE)	in planning (East Ring)
	Automated Innovation Lab (CDISE)	in planning (East Ring)
	Advanced Computing (CDISE)	in planning (East Ring)
	Visual Sensing and Data Fusion (CDISE)	in planning (East Ring)
	Virtual Reality Lab (CDISE)	in planning (East Ring)
	Distributed Intelligent Systems (CDISE)	in planning (East Ring)
	Biomedical Image Analysis (CDISE)	in planning (East Ring)
	Quantum Software (CDISE)	in planning (East Ring)
	Molecular Informatics (CDISE)	in planning (East Ring)
	Artificial Intelligence (CDISE)	in planning (East Ring)
	Computer Vision (CDISE)	in planning (East Ring)
	Industrial Analytics Lab (CDISE)	in planning (East Ring)
	Prototype Lab (CDISE)	in planning (East Ring)
	CyberAcademy (CDISE)	in planning (East Ring)
Life Sciences & Biomedicine	Student teaching laboratory (CDIBB)	operational (Technopark)
	Laboratory at the Institute of Gene Biology (CDIBB)	operational (Institute of Gene Biology)
	Joint Lab Skoltech – All-Russia Rice Research Institute (CDIBB)	operational (All-Russia Rice Research Institute)
	Joint Research Center Skoltech – Peter the Great St.Petersburg Polytechnic University (CDIBB)	operational (SPbPU)
	Joint Lab Skoltech – Institute of Developmental Biology (CTB)	operational (Institute of Developmental Biology)
	Joint Lab Skoltech – Moscow State University (CTB)	operational (MSU)
	Mass-Spectrometry Lab (CTB)	TPOC-4 (shared facilities in East Ring)

RESEARCH FACILITIES

Skoltech current research facilities (in total 6,150 sq.m) were established to support its strategy and enable collaborations. Several world-class laboratories are fully operational: Enhanced Oil Recovery, Additive Manufacturing, Concurrent Engineering Design, Intelligent Space Robotics, 4D Analysis, Information Technologies for Advanced Manufacturing, Internet of Things, Hybrid Photonics, Nanomaterials, Design, Manufacturing and Materials, Mass Spectrometry, Electrochemical Energy Storage, Soil Informatics, Tensor Networks and a refitted Masterskaya.

All laboratories are outfitted with state-of-the art equipment; the researchers, engineers and technical staff have been trained at leading international universities to operate and maintain the equipment.

In 2017, the Masterskaya laboratory co-operated with several companies, including YG1 and Renova AI on the joint use of the infrastructure to demonstrate the companies’ products. In collaboration with the IoT laboratory and TwinsTech, a pilot project for investigating interactions of modern

TARGET DOMAIN	LABORATORY	STATUS (LOCATION)
	Student teaching laboratories (3x) (CDIBB)	in planning (East Ring)
	Research laboratories (2x) (CDIBB)	in planning (East Ring)
	Research laboratory (CDIBB)	in planning (East Ring)
	Research laboratory (CDIBB)	in planning (East Ring)
	Research laboratory (CDIBB)	in planning (East Ring)
	Research laboratory (CDIBB)	in planning (East Ring)
	Research laboratory (CDIBB)	in planning (East Ring)
	Functional Genomics laboratory (CTB)	in planning (East Ring)
Cutting-edge Engineering & Advanced Materials	Composite Materials and Structures laboratory (CDMM)	TPOC-3 / TPOC-4, also planned in East Ring
	Additive Manufacturing laboratory (CDMM)	operational (TPOC-3), also planned in East Ring
	IT for Advanced Manufacturing laboratory (CDMM)	operational (TPOC-3), also planned in East Ring
	Micro- and Nanomechanics laboratory (CDMM)	operational (TPOC-3), also planned in East Ring
	Mechanical Testing and Material Characterization laboratory (CDMM)	operational (TPOC-3), also planned in East Ring
	Production of aluminum honeycomb panels laboratory (CDMM)	operational (TPOC-3)
	Concurrent Engineering Design laboratory (SC)	operational (TPOC-3), also planned in East Ring
	Intelligent Space Robotics Lab (SC)	operational TPOC-3 / TPOC-4, also planned in East Ring
	Joint Skoltech – Oerlikon lab (CDMM)	under construction in TPOC-2, also planned in East Ring
	System and Product Development laboratory (SC)	in planning (East Ring)
	Space Data laboratory (SC)	in planning (East Ring)
	Space Technologies Laboratory (Nanosatellites, SC)	in planning (TPOC-3 / East Ring)
Energy Efficiency	Electrochemical Energy Storage laboratory (CEE)	operational (TPOC-3), also planned in East Ring
	Pilot Scale Cathode Materials Manufacturing (CEE)	operational (TPOC-3), also planned in East Ring
	Computational Materials Discovery laboratory (CEE)	operational (TPOC-4), also planned in East Ring
	Energy Systems laboratory (CES)	operational (TPOC-3), also planned in East Ring
	Enhanced Oil Recovery Lab (CHR)	operational (Renova Lab), also planned in East Ring
	Joint Research Center Skoltech-Dmitry Mendeleev University of Chemical Technology of Russia (CEE)	operational (Dmitry Mendeleev University)
	Joint Research Center Skoltech - Institute of Problems of Chemical Physics (CEE)	operational (Institute of Problems of Chemical Physics)
Quantum Technology	Nanomaterials laboratory (CPQM)	operational (TPOC-3), also planned in East Ring
	Hybrid Photonics laboratory (CPQM)	operational (TPOC-3), also planned in East Ring
	Plasmonics laboratory (CPQM)	operational (TPOC-4), also planned in East Ring
	Biophotonics laboratory (CPQM)	operational (TPOC-3), also planned in East Ring

TARGET DOMAIN	LABORATORY	STATUS (LOCATION)
	Atomic Clock laboratory (CPQM)	under construction (TPOC-4), also planned in East Ring
	Nano Electronic and Opto Electronic Lab (CPQM)	in planning (East Ring)
	Optic Communication Lab (CPQM)	in planning (East Ring)
	Office premises (CAS)	operational (TPOC-4), also planned in East Ring
Advanced Studies		
Shared Facilities	HPC Data Center	operational (TPOC-4), also planned in East Ring
	Histology and Phenotyping laboratory	operational (TPOC-4), also planned in East Ring
	Biological Imaging laboratory	operational (TPOC-4), also planned in East Ring
	Genome Sequencing laboratory	operational (TPOC-4), also planned in East Ring
	Mass Spectrometry laboratory	operational (TPOC-4), also planned in East Ring
	Workshops (Student Masterskaya)	operational (TPOC-4), also planned in East Ring
	Vivarium	in planning (East Ring)
	Cleanroom	in planning (East Ring)
	Advanced Imaging	in planning (East Ring)

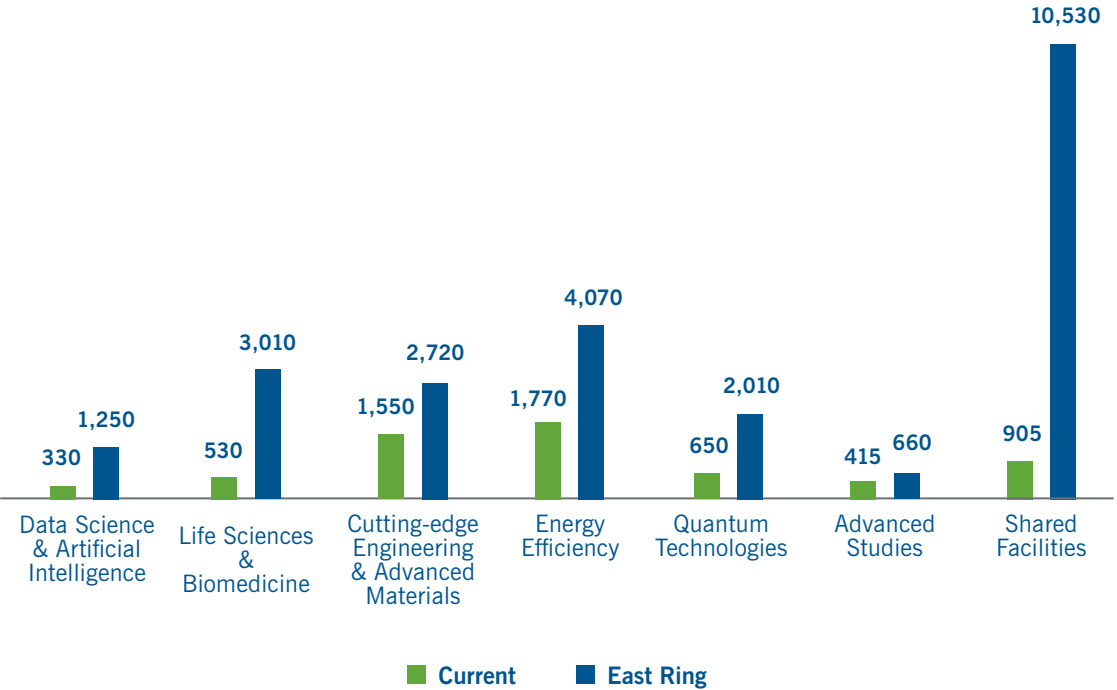


Figure 3. Skoltech research infrastructure by target domain (including shared facilities), in sq.m

GRANT SUPPORT

New grants

In 2017, 49 grant proposals within national and international programs (i.e. Horizon 2020, the BRICS framework program in science and innovation, calls for proposals for priority areas (Russian Science Foundation), the Russian Presidential Program for Young Scientists)

were submitted by Skoltech faculty and researchers. In all, 19 proposals were awarded funding equal to 256.3 million RUB. While some research projects involve the work of more than one CREI, CDISE, CPQM and CEE have the largest funding recipients (Fig. 4).

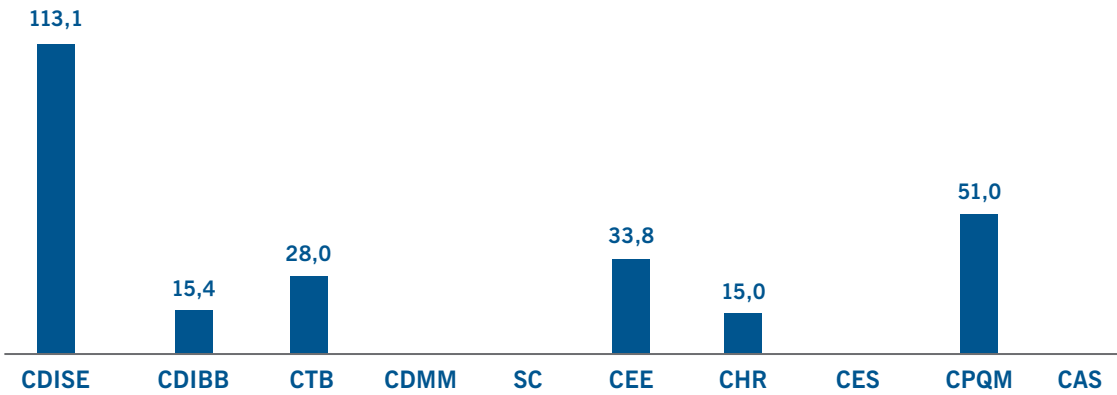


Figure 4. New grant awards in 2017 (mln RUB)

Awards from the Russian Science Foundation and the Ministry of Education and Science comprised the largest portions, amounting to 118,8 million RUB and 90

million RUB, respectively. The third highest sponsor is European Funding Horizon 2020 (363,000 EUR). The distribution of newly awarded grants is presented below:

RUSSIAN SCIENCE FOUNDATION	
Total amount	118,8 mln RUB
Winners (PIs)	Prof. Ivan Oseledets (CDISE) 18.0 mln RUB Prof. Albert Nasibulin (CPQM) 18.0 mln RUB Prof. Boris Fine (CPQM) 18.0 mln RUB Dr. Andrey Kazak (CHR) 15 mln RUB Dr. Oleg Lychkovskiy (CPQM) 15.0 mln RUB Dr. Alexander Kvashnin (CEE) 15.0 mln RUB Prof. Alexey Buchachenko (CEE) 13.8 mln RUB Dr. Igor Ostanin (CDISE) 3.0 mln RUB Dr. Olga Sergeeva (CTB) 3.0 mln RUB

MINISTRY OF EDUCATION AND SCIENCE

Total amount	90,0 mln RUB (Megagrant)
Winners (PIs)	Prof. Andrzej Cichocki (CDISE) – establishing the laboratory “Tensor Networks and Deep Learning for Applications in Data Mining”

HORIZON 2020

Total amount	363 000, EUR (25 mln RUB)
Winners (PIs)	Prof. Evgeny Nikolaev (CTB) – infrastructural project “European Network of Fourier-Transform Ion-Cyclotron-Resonance Mass Spectrometry Centers” will be implemented during 2018-2020 in consortia with the University of Warwick, the National Center for Scientific Research (CNRS), the University of Liege and the University La Sapienza.

RUSSIAN FOUNDATION FOR BASIC RESEARCH

Total amount	10,5 mln RUB
Winners (PIs)	Prof. Artem Abakumov (CEE) 5.0 mln RUB Prof. Konstantin Severinov (CDIBB) 3.4 mln RUB Prof. Ivan Oseledets (CDISE) 2.1 mln RUB

OTHER (PHILIPP MORRIS)

Total amount	12,0 mln RUB
Winners (PIs)	Prof. Konstantin Severinov (CDIBB)

Projects implemented in 2017

The total amount of grant funding (contracted) in 2017 reached 141.9 mln RUB. The distribution of these funds between the CREIs is presented below.

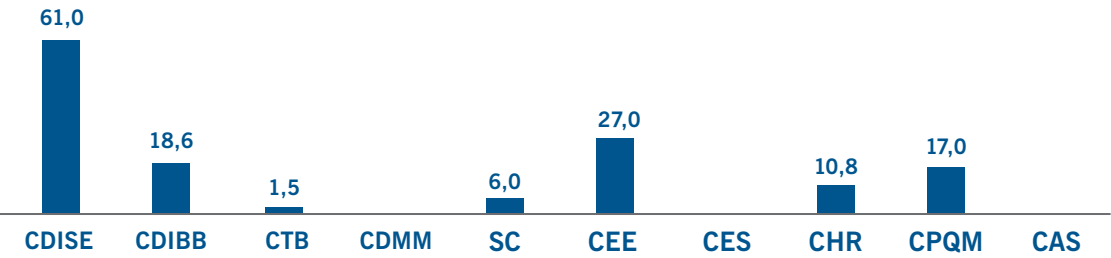


Figure 5. Grant funding 2017 by CREI (mln RUB)

19
grant
proposals
are awarded
funding of
256
mln RUB

29 projects were carried out by Skoltech research teams during the year:

PRINCIPAL INVESTIGATOR	CREI	PROJECT	FUNDING AGENCY	TOTAL GRANT	TIMELINE
Dr. Dmitry Gilyarov	CDIBB	New antibacterials from natural products: Structure of thiazole/oxazole heterocyclase	RFBR	2,3 mln RUB	2016-2018
Dr. Evgeny Klimuk	CDIBB	Study of the regulation of expression of the genes of the restriction-modification Kpn2I system	RFBR	5,1 mln RUB	2016-2018
Prof. Konstantin Severinov	CDIBB	Engineering thermophage particles for studying virus assembly	RFBR	2,25 mln RUB	2016-2018
Prof. Konstantin Severinov	CDIBB	Identification of Key genetic/epigenetic Marker(s) in cervical carcinogenesis and development of corresponding Molecular Therapeutics for precision medicine of cervical cancer	RFBR	3,4 mln RUB	2017-2018
Prof. Philipp Khaitovich	CDIBB	Organization of neuronal response mechanisms in primate, rodent and invertebrate brains	RSF	18 mln RUB	2016-2018
Dr. Alexander Mikhalev	CDISE	Rectangular maximum volume submatrices: theory and applications	RFBR	1,35 mln RUB	2016-2018
Dr. Alexei Naumov	CDISE	Spectral analysis of random high-dimensional matrices	RFBR	0,9 mln RUB	2017-2018
Prof. Andrzej Cichocki	CDISE	Tensor methods and machine learning methods for modeling and optimization of complex multiparametric systems	Ministry of Education and Science	90 mln RUB	2017-2019
Dr. Igor Ostanin	CDISE	Nonlocal methods for modeling physical media	RFBR	5,1 mln RUB	2016-2018
Dr. Igor Ostanin	CDISE	Massively parallelized environment for modeling the mechanics of nanotubes and nanoparticles using the discrete element method	RSF	3 mln RUB	2017-2019
Dr. Igor Ostanin	CDISE	Multiscale mechanical modeling of carbon nanotube based materials using generalized discrete element method	RFBR	1,35 mln RUB	2016-2018

PRINCIPAL INVESTIGATOR	CREI	PROJECT	FUNDING AGENCY	TOTAL GRANT	TIMELINE
Prof. Ivan Oseledets	CDISE	Methods for solving integral and differential equations on ultrafine grids of a special structure	RFBR	6 mln RUB	2016-2018
Prof. Ivan Oseledets	CDISE	Tensor methods and machine learning methods for modeling and optimization of complex multiparametric systems	RSF	18 mln RUB	2016-2018
Prof. Ivan Oseledets	CDISE	Solution methods for large linear systems with block low-rank and sparse matrices	RFBR	2,1 mln RUB	2017-2019
Dr. Maxim Rakhuba	CDISE	Fast tensor approach to electronic structure calculation	RFBR	1,35 mln RUB	2016-2018
Dr. Alexander Kvashnin	CEE	Computational design for new materials with optimal hardness and fracture toughness	RSF	15 mln RUB	2017-2019
Prof. Alexei Buchachenko	CEE	Modeling of stability, structure and spectra of atoms and small molecules in inert gas crystals	RSF	13,8 mln RUB	2016-2018
Prof. Andriy Zhugaevich	CEE	Understanding the dependence of charge transport on morphology in organic semiconductor films	Volkswagen	0,04 mln EUR	2017-2018
Prof. Artem Abakumov	CEE	Nanoarchitected Fluorophosphate Cathode & Phosphorene-Based Hybrid Anode for Sodium-Ion Batteries	RFBR	3,4 mln RUB	2017-2018
Prof. Artem Abakumov	CEE	Novel mixed polyanion cathode materials for metal-ion batteries	RFBR	2,1 mln RUB	2017-2019
Prof. Artem Oganov	CEE	New methods for predicting materials with optimal properties	RSF	18 mln RUB	2016-2018
Prof. Keith Stevenson	CEE	Design of advanced organic cathode materials for lithium and sodium batteries	RSF	18 mln RUB	2016-2018
Dr. Diana Susarova	CEE	Design of self-assembling donor-acceptor block-copolymers for highly efficient and stable solar cells	RFBR	4,9 mln RUB	2016-2018

PRINCIPAL INVESTIGATOR	CREI	PROJECT	FUNDING AGENCY	TOTAL GRANT	TIMELINE
Dr. Andrey Kazak	CHR	Pore Water as a Key Component of Hydrocarbon Reservoir Model of the Bazhenov Source Rock, West Siberia, Russian Federation	RSF	15 mln RUB	2017-2019
Dr. Evgeniy Chuvilin	CHR	Gas hydrates as a source of geological risk in the exploration of oil and gas fields in the Arctic	RSF	17 mln RUB	2016-2018
Prof. Albert Nasibulin	CPQM	New generation of transparent, conductive, flexible and stretchable films of single-walled carbon nanotubes produced by aerosol CVD synthesis method	RSF	18 mln RUB	2017-2019
Prof. Boris Fine	CPQM	Statistical behavior of thermally isolated many-body quantum systems	RSF	18 mln RUB	2017-2019
Dr. Oleg Lychkovskiy	CPQM	Quantum adiabaticity in many-particle systems	RSF	15 mln RUB	2017-2019
Dr. Olga Sergeeva	CTB	Validation of long non-coding RNA LL35 as a regulator of gene expression and a potential target for therapy	RSF	3 mln RUB	2017-2019

Trends in grant funding

The tables and charts below summarize the general trends of Skoltech grant support occurred from 2015 through 2017, as well as anticipated for 2018 through 2020.

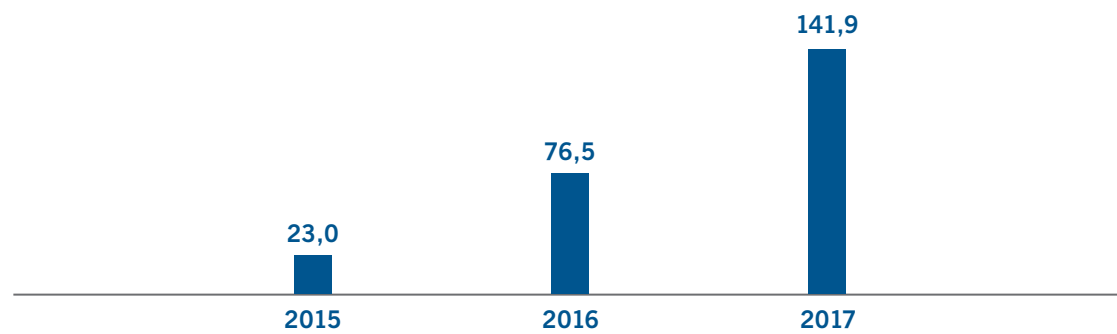


Figure 6. Skoltech grant support in 2015-2017 (mln RUB)

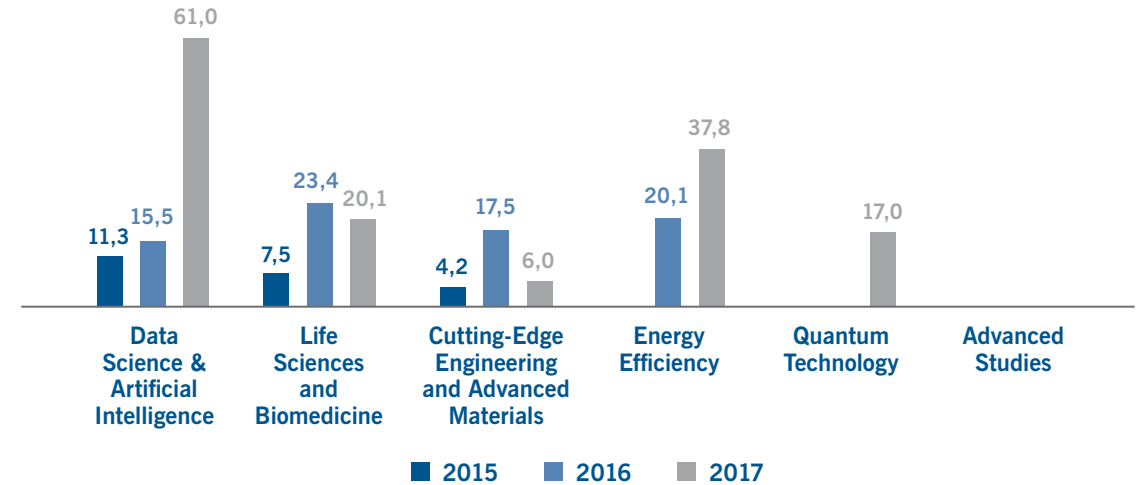


Figure 7. Skoltech grant support in 2015-2017 by target domain

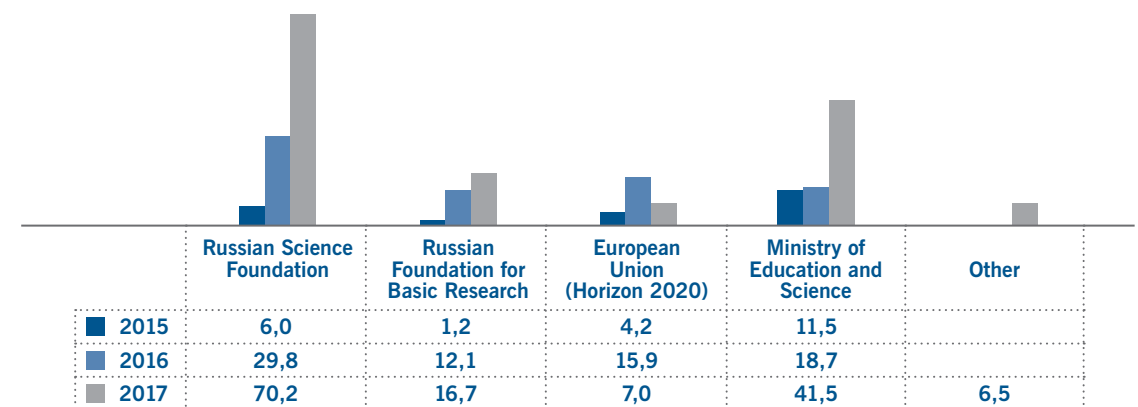


Figure 8. Skoltech grant support 2015 - 2017 by funding source

The amount of funding secured for the period of 2018-2020 (as of December, 2017) is 205.9 million RUB. The distribution of funding per CREI and Target Domain is presented below.

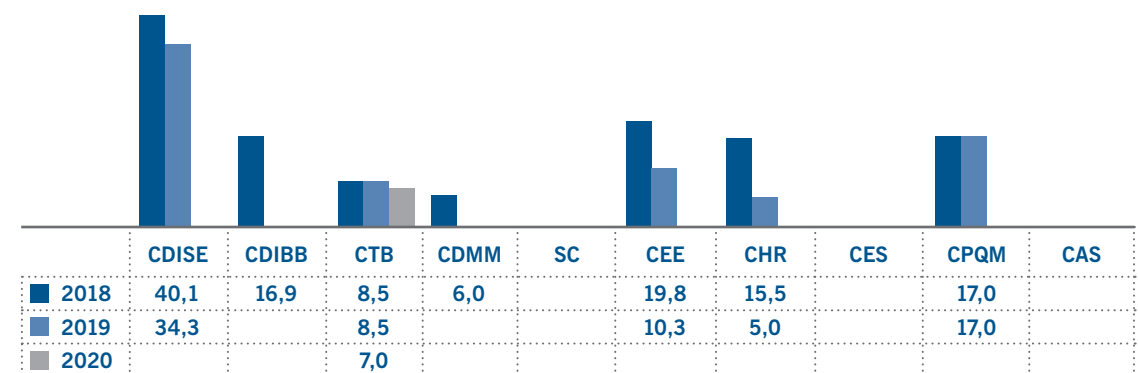


Figure 9. Grant funding secured for 2018-2020, by CREI (mln RUB)

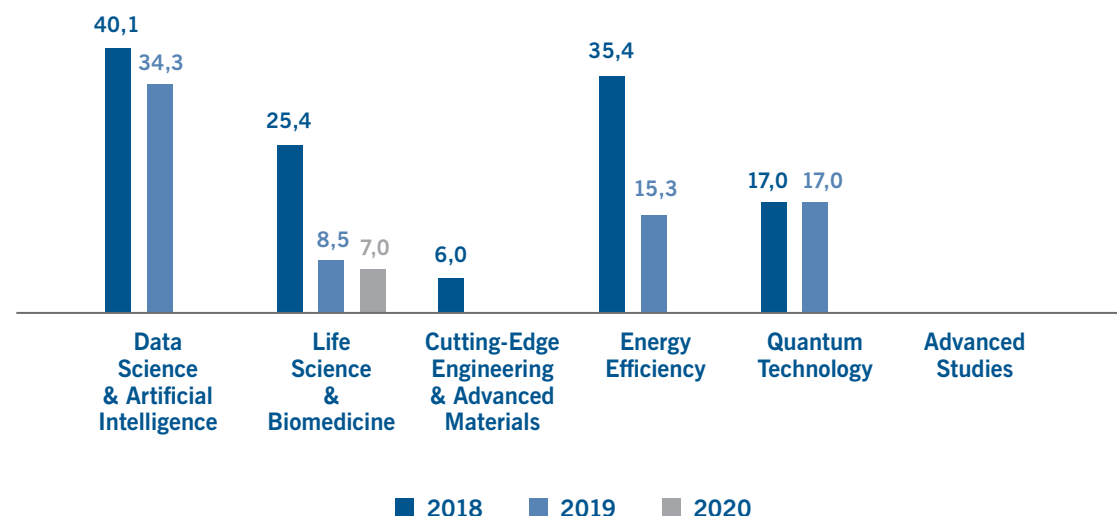


Figure 10. Grant funding secured for 2018-2020, by target domain (mln RUB)

PUBLICATION ACTIVITY

This year Skoltech maintained high scholarly productivity in terms of the number of papers published in reputable international journals. Strong indicators of Institutional success are presented below.

Skoltech received the **Web of Science Rising Star of Citation Impact** award for its surge in publications. This award is presented to research institutions that significantly increase their publication activity over the year both with respect to quantities of published articles and subsequent citation scores. Prof. Konstantin Severinov (CDIBB) and Prof. Artem Oganov (CEE) were honored for being among the most highly cited researchers in Russia.

Also worth noting, Skoltech ranked number three in Russia in the **Nature Index 2017** following the Russian Academy of Sciences and Moscow State University (per articles count in the Nature & Science journal group)⁷. The following Skoltech affiliated papers were specifically featured:

- Raven, A; Lu, WY; Man, TY; Ferreira-Gonzalez, S; O'Duibhir, E; Dwyer, BJ; Thomson, JP; Meehan, RR; Bogorad, R; **Koteliansky, V**; **Kotelevtsev, Y**; Ffrench-Constant, C; Boulter, L; Forbes, SJ. Cholangiocytes act as facultative liver stem cells during impaired hepatocyte regeneration. NATURE 547(7663), 350-+ (2017)
- Alessandro Furlan, Vyacheslav Dyachuk, Maria Eleni Kastriti, Laura Calvo-Enrique, Hind Abdo, Saida Hadjab, Tatiana Chontorotzea, **Natalia Akkuratova**, Dmitry Usoskin, Dmitry Kamenev, Julian Petersen, Kazunori Sunadome, Fatima Memic, Ulrika Marklund, Kaj Fried, Piotr Topilko, Francois Lallemand, Peter V. Kharchenko, Patrik Ernfors, Igor Adameyko. Multipotent peripheral glial cells generate neuroendocrine cells of the adrenal medulla. SCIENCE 07 Jul 2017: Vol. 357, Issue 6346, eaal3753
- Manukyan, L; Montandon, SA; Fofonjka, A; **Smirnov, S**; Milinkovitch,

MC. A living mesoscopic cellular automaton made of skin scales. NATURE 544(7649), 173-+ (2017)

- Sohail, M; Vakhrusheva, OA; Sul, JH; Pulit, SL; Francioli, LC; van den Berg, LH; Veldink, JH; de Bakker, PIW; **Bazykin, GA**; Kondrashov, AS; Sunyaev, SR. Negative selection in humans and fruit flies involves synergistic epistasis. SCIENCE 356(6337), 539-542 (2017).
- Dong, X; **Oganov, AR**; Goncharov, AF; Stavrou, E; Lobanov, S; Saleh, G; Qian, GR; Zhu, Q; Gatti, C; Deringer, VL; Dronskowski, R; Zhou, XF; Prakapenka, VB; Konopkova, Z; Popov, IA; Boldyrev, AI; Wang, HT. A stable compound of helium and sodium at high pressure. NATURE CHEMISTRY 9(5), 440-445 (2017)
- Yin, H; Song, CQ; Suresh, S; Wu, QQ; Walsh, S; Rhym, LH; Mintzer, E; Bolukbasi, MF; Zhu, LJ; Kauffman, K; Mou, HW; Oberholzer, A; Ding, JM; Kwan, SY; Bogorad, RL; **Zatsepin, T**; **Koteliansky, V**; Wolfe, SA; Xue, W; Langer, R; Anderson, DG. Structure-guided chemical modification of guide RNA enables potent non-viral in vivo genome editing. NATURE

BIOTECHNOLOGY 35(12), 1179-+ (2017)

- Berloff, NG**; Silva, M; Kalinin, K; Askitopoulos, A; Topfer, JD; Cilibrizzi, P; Langbein, W; **Lagoudakis, PG**. Realizing the classical XY Hamiltonian in polariton simulators. NATURE MATERIALS 16(11), 1120-1126 (2017)

As presented in the Nature Index Institutional profile (Fig.11), Skoltech published the majority of its papers in collaboration with international partners. Among the Institute's key international collaborators were: the Massachusetts Institute of Technology (United States), the University of Texas at Austin (United States), State University of New York at Stony Brook (United States), the University of Southampton (United Kingdom), Rutgers University (United States) and the University of Geneva (Switzerland). Domestic collaborations are mainly presented by the Russian Academy of Sciences, Lomonosov Moscow State University, Moscow Institute of Physics and Technology, Peter the Great St. Petersburg Polytechnic University.

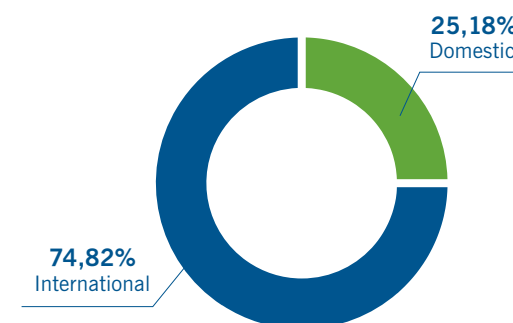


Figure 11. Skoltech affiliated publications 2017 (Nature & Science journal group)

In 2017, Skoltech academic staff and students published 512 papers that were indexed in WoS and/or Scopus. Of these, 348 were authored by faculty members.

There was an increase in the number of papers with international and Russian partners, as well as with the representatives of industrial companies (see Table 3).

Web of Science
Rising Star
of Citation
Impact award
2017
for significant
increase of
publication
activity

⁷ Status end of 2017.

Table 3. Key metrics of Skoltech publication activity

INDICATOR	2015	2016	2017
Skoltech affiliated publications indexed in WoS, Scopus	237	352	512
Publications with international partners	134	221	309
Publications with Russian partners	147	227	366
Publications with industrial partners	32	45	72
Faculty co-authored publications, indexed in WoS, Scopus	188	259	348
MSc and PhD students co-authored publications	28	59	99

The charts below summarize general Skoltech publication trends with regards to productivity and collaborations during the period of 2015-2017.

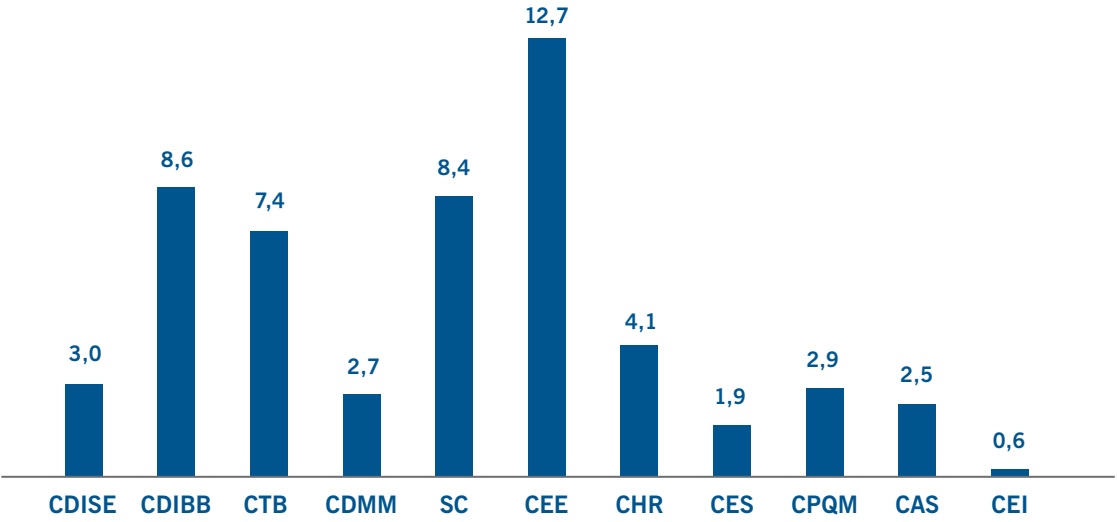


Figure 12. Faculty authored publications indexed in WoS, Scopus per faculty FTE (2017)

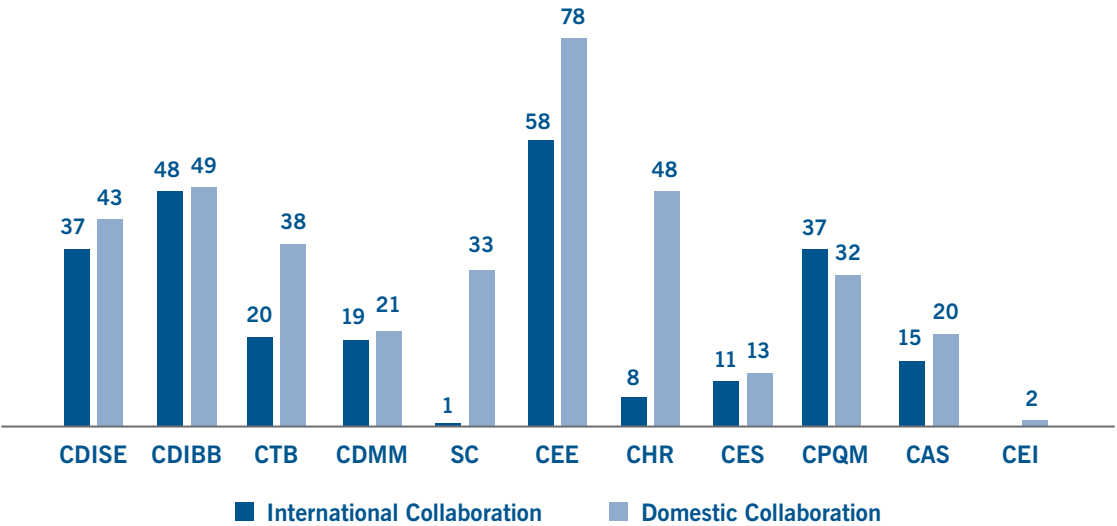


Figure 13. CREIs publications by collaboration (incl. CEI), (2017)

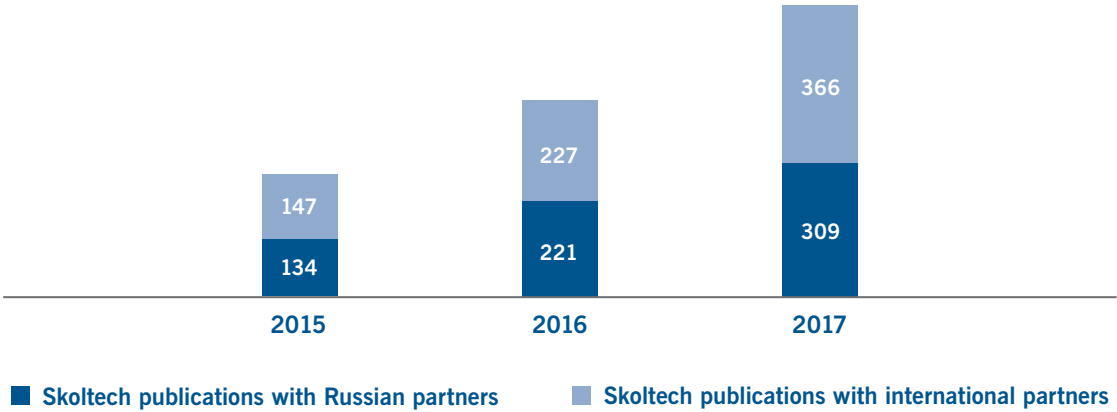


Figure 14. Skoltech affiliated publications indexed in WoS, Scopus by collaborators (2015-2017)

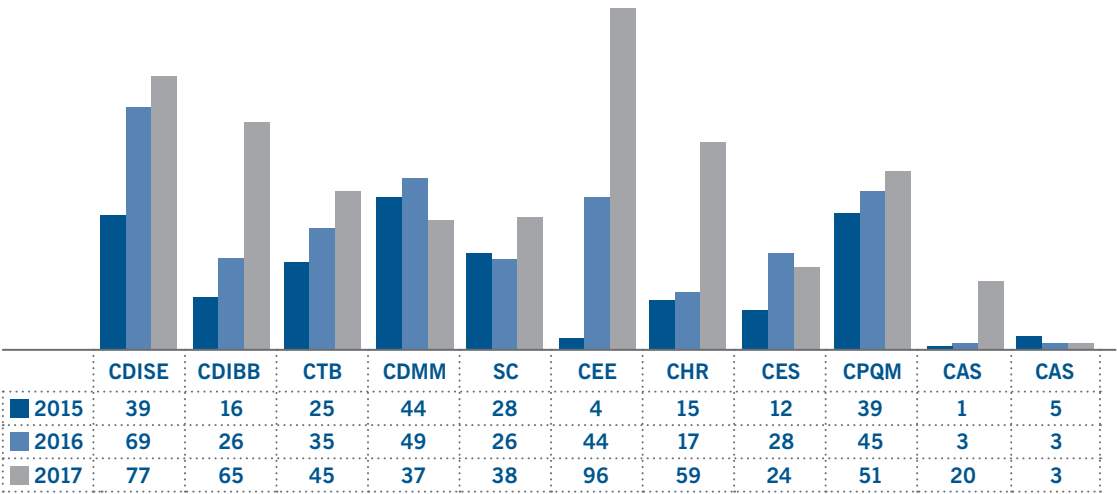


Figure 15. Skoltech affiliated publications indexed in WoS, Scopus per CREI (incl. CEI), (2015 – 2017)

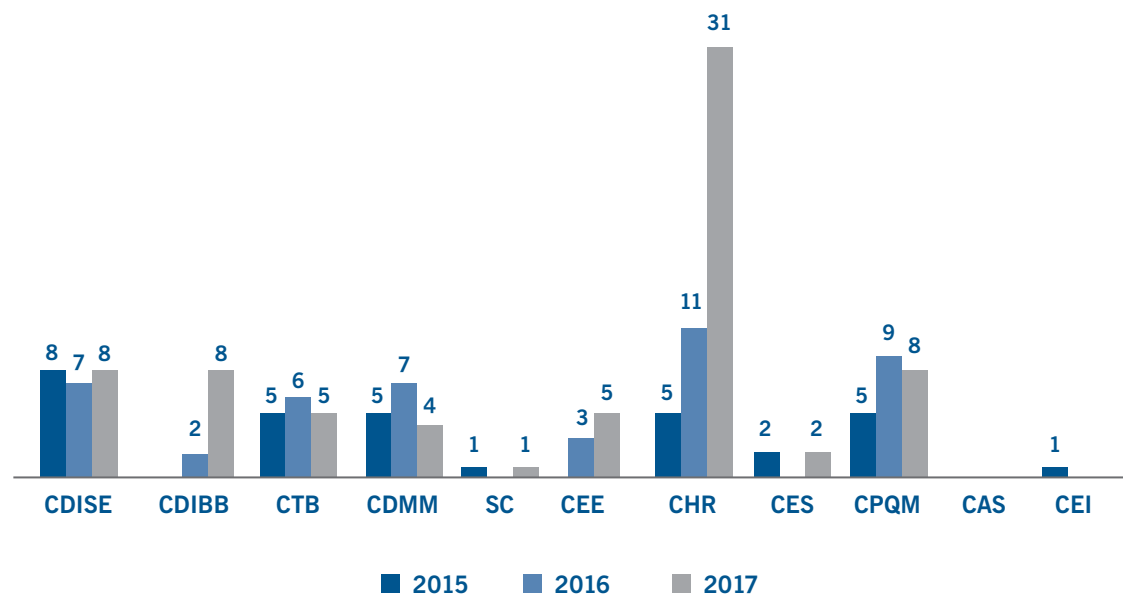


Figure 16. Skoltech affiliated publications in a partnership with industrial companies by CREI (incl. CEI) (2015 – 2017)

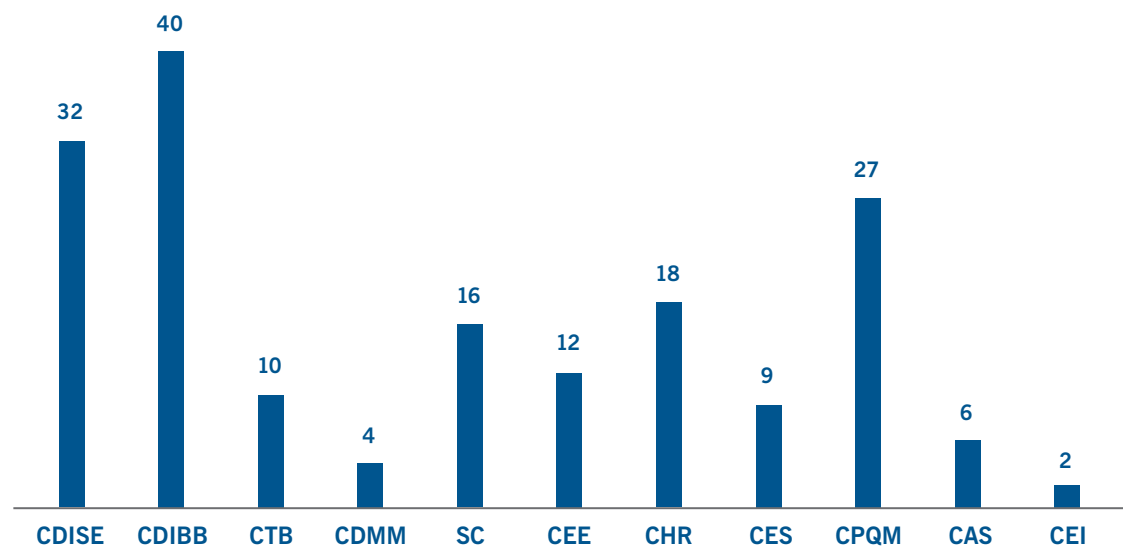


Figure 17. Publications with MSc and PhD students per CREI (incl. CEI) (2015-2017)

CREI PARTNERSHIP PROGRAMS

Skoltech is developing networks with top international and Russian universities and research teams in the areas identified in the research priorities. Capacity building for Skoltech leverages faculty, postdoc and student exchange programs, as well as joint research projects, and supports a wide range of education and research events. The initial concept was that many partners would be funded by Skoltech. In this regard a number of one- to six-year MRAs were executed and 21 of them were carried out during the period of 2015-2017. Increasingly, Skoltech has moved to a more mature model and some partnerships were discontinued as they became no longer effective.

In 2017, a new MRA execution procedure was enforced in order to streamline the assessment process. In accordance with the new procedure, Skoltech Dean of Research oversees the execution of the MRAs, while the Academic Council Committee on Research Programs and Projects reviews and evaluates scope of activities and performance.

During the year, 27 research-driven projects were implemented within the framework of the respective CREI research focus areas. In addition to collaborative research contributions, the partner organizations have fostered Skoltech capacity building, including the following deliverables:

- joint publications,
- lectures and courses for Skoltech (CES, CEE), hosting Skoltech students for conducting research projects (CES, CDMM, CTB, CEE),
- provision of access to the infrastructure and facilities (CEE, CTB, CHR), assistance with design and commissioning of laboratories (CES, Smart Grids),
- joint scientific events (CES, CHR, CDMM, CTB, CEE),
- support with preparing and submission of proposals for funding to Russian and international governmental organizations, agencies, industry, as well as preparation of joint patent applications (CHR).

MRAs active in 2017

CES Caltech, United States The University of Newcastle upon Tyne, United Kingdom Massachusetts Institute of Technology, United States	Ongoing since 2015 Ongoing since 2014 Project of 2015-2017
CHR Heriot-Watt University, United Kingdom University of Calgary, Canada Bashkir State University, Russia Institute Physics of the Earth, Russia Institute of Petroleum and Gas Geology and Geophysics, Russia	Ongoing since 2014 Ongoing since 2014 Ongoing since 2014 Ongoing since 2014 Ongoing since 2014
CDMM University of Dayton, United States Katholieke Universiteit Leuven, Belgium Bashkir State University, Russia	Ongoing since 2014 Terminated in 2017 Ongoing since 2016
CTB Massachusetts Institute of Technology, United States Lomonosov Moscow State University, Russia	Ongoing since 2013 Ongoing since 2013
CEE Massachusetts Institute of Technology, USA Lomonosov Moscow State University, Russia	Ongoing since 2013 Ongoing since 2013
CPQM St. Petersburg National Research Academic University of RAS, Russia	Ongoing since 2017

NEXT GENERATION PROGRAM: SKOLTECH-MIT JOINT PROJECTS

The NGP is one of the formats of the Skoltech-MIT partnership to establish and promote a mutually beneficial long-term collaboration in research, education and innovation through joint research-driven projects, as well as the further development of Skoltech streams within the development programs. During the year, the projects selected under the first Call (2015) were implemented:

SKOLTECH PROJECT LEADER (PL)	MIT PL AND CO-PL	TITLE
Prof. Artem Abakumov, CEE	Yet-Ming Chiang, Kyocera Professor, National Academy of Engineering	Exploring Potassium-Ion Batteries
Prof. Natalia Berloff, CPQM Prof. Pavlos Lagoudakis, CPQM	Keith Adam Nelson, Haslam and Dewey Professor of Chemistry Department	Polaritonics Providing a Paradigm Shift in Optoelectronics
Prof. Aldo Bischì, CES Prof. Janusz Bialek, CES	Konstantin Turitsyn, Assistant Professor, Mechanical Engineering	Integration and Control of Heat and Power Systems with Variable Loads
Prof. Boris Fine, CPQM	Nuh Gedik, Associate Professor, Physics	Investigations of High-Temperature Superconductors and Other Complex Quantum Materials
Prof. Victor Lempitsky, CDISE	Associate Professor Associate Member Department of Biological Engineering, MIT Broad Institute of MIT and Harvard Anne Carpenter, Imaging Platform Director, Carpenter Lab PI, Broad Institute of MIT and Harvard	Deep Learning Tools and Algorithms for Cell Image Analysis
Prof. Albert Nasibulin, CPQM	A. John Hart, Associate Professor, Dept. of Mechanical Engineering Xuanhe Zhao, Associate Professor, Dept. of Mechanical Engineering	Carbon Nanomaterial Manufacturing Platforms for Interactive Surfaces and Smart Prosthetics
Prof. Evgeny Nikolaev, SC	Luis F. Velásquez-García, Principal Scientist, Microsystems Technology Laboratories	3d-Printed, Miniaturized Cassinian Trap Mass Spectrometer for Space Research and General Ambient Analysis Applications
Prof. Ivan Oseledets, CDISE	Luca Daniel, Professor of Electrical Engineering and Computer Science, Electrical Engineering and Computer Science	High-Dimensional Uncertainty Quantification: from Component to Systems Design
Prof. Timofei Zatsepin, CTB	Daniel Anderson, Associate Professor, Chemical Engineering, Institute for Medical Engineering and Science	Regulation of Antitumor Response via Modulation of Ubr-Ubiquitin Ligases In Vivo
Prof. Athanasios Polimeridis, CDISE	Jacob White, Cecil H. Green Professor, Electrical Engineering and Computer Science	Next Generation Fast Methods for Medical and Nanoscale Technology

SKOLTECH PROJECT LEADER (PL)	MIT PL AND CO-PL	TITLE
Prof. Konstantin Severinov, CDIBB	Feng Zhang, James & Patricia Poitras Professor in Neuroscience, Department of Brain and Cognitive Sciences	Search and Development of New Genome Editing Tools for Biomedicine and Biotechnology
Prof. Alexander Shapeev, CDISE	Ju Li, Battelle Energy Alliance Professor, Nuclear Science and Engineering & Materials Science and Engineering	Machine Learning Elastic Strain Engineering
Prof. Mikhail Skvortsov, CPQM	Karl Berggren, Full Professor, Quantum Nanostructures and Nanofabrication Group	Quantum Materials for Superconducting Nanophotonics
Prof. Pavel Troshin, CEE	Tonio Buonassisi, Associate Professor, Mechanical Engineering	Improved Stability and Performance in Highly Efficient Lead-Free Hybrid Perovskite Solar Cells
Prof. Dzmitry Tsetserukou, SC	Kamal Youcef-Toumi, Professor, Director of Mechatronics Research Lab, Department of Mechanical Engineering	RecyBot: High-Speed Intelligent Robotic System with Computer Vision for Electronics Recycling

The projects interim reports are to be received for review in February, 2018.
In 2017, a second Call for Proposals was held to allow recently hired faculty to benefit from the opportunity to collaborate with MIT. Out of the 11 White Papers received – five were

selected for submission of Full Proposals. All Full Proposal were evaluated by the group of four experts proposed by the Skolkovo Foundation and MIT. In addition, a joint Skoltech/MIT Steering Committee was established to consider peer reviews and make the final evaluation.

Four projects were supported and partly co-funded by MIT:

SKOLTECH PROJECT LEADER (PL)	MIT PL	TITLE
Prof. Evgeny Burnaev, CDISE	Justin Solomon, X-Consortium Career Development Assistant Professor, MIT Department of Electrical Engineering & Computer Science	Simulation and Transfer Learning for Deep 3D Geometric Data Analysis
Dr. Grigory Kabatiansky, CDISE	Yury Polyanskiy, Associate Professor, Electrical Engineering and Computer Science (EECS)	Theoretical fundamentals of random multiple-access channels with applications to massive machine-type communications and digital finger printing
Prof. David Pozo, CES	Juan Pablo Vielma, Associate Professor, Sloan School of Management	Energy Systems Planning for Government Regulations: New Formulations, Models and Algorithms
Prof. Keith Stevenson, CEE	Fikile Brushett, Assistant Professor, Chemical Engineering Adam Willard, Assistant Professor, Chemistry Department	Lithium Redox Flow Batteries for High Power and High Energy Density Energy Storage

The NGP projects are 18 months in duration with the possibility of extension, subject to evaluation of the results and availability of funding. Project funding was released in December 2017; the interim reports are expected in February 2019.

BIOMEDICAL INITIATIVE

The Biomedical Initiative is an interdisciplinary cross-CREI effort aimed at establishing collaboration with the Moscow International Medical Cluster at Skolkovo. The Initiative focuses on launching new projects that will be further integrated into a solid cross-CREI program to refine and solidify Skoltech in biomedical research, education and innovation.

The Call for Proposals was announced in May 2017. In accordance with the formal requirements, the proposals had to be initiated by at least two faculty and/or research scientists (co-Project Leaders) representing at least two different CREIs. The evaluation took place in July 2017. An expert panel compiled by the Skolkovo Foundation provided reviews of the six Full Proposals that were prepared (12 White Papers were initially received). The panel was formed by six reviewers from the United States, Germany and Israel. The Steering Committee made the final selection of the following projects:

PROJECT LEADER 1	PROJECT LEADER 2	TITLE
Prof. Georgii Bazykin, CDIBB	Dr. Dmitry Yarotsky, CDISE	Deciphering the Cause of Human Pregnancy Loss by Exome Analysis of Abortuses
Prof. Mikhail Gelfand, CDIBB	Dr. Alexander Bernstein, CDISE	Machine Learning and Pattern Recognition for the Development of Diagnostic and Clinical Prognostic Prediction Tools in Psychiatry, Borderline Mental Disorders, and Neurology
Prof. Konstantin Severinov, CDIBB	Prof. Ivan Oseledets, CDISE	Personalized Bacteriophage Therapy of Clostridium Difficile Infections
Prof. Timofei Zatsepin, CTB	Prof. Albert Nasibulin, CPQM	Magnetic Nanoparticles and Carbon Nanotubes as Enhancers for Targeted RNA Delivery in vivo

Project funding was released in September 2017.

The most essential educational initiatives to build Academic Excellence are aimed at the following goals:

1. Develop globally competitive academic programs;
2. Implement new technologies and practices to educate *centennials (digital natives)* efficiently;
3. Create a unique educational environment – so-called “Learning Commons” – which will include digital environments

GLOBALLY COMPETITIVE ACADEMIC PROGRAMS

The main achievement of 2017 is that all MSc and PhD educational programs at Skoltech have received Russian state accreditation. The state accreditation permits Skoltech to issue state diplomas, which integrates the Institute in the Russian higher educational landscape and makes it more competitive.

All graduate programs (10 MSc and 7 PhD programs) are oriented toward six Target Domains: Data Science & Artificial Intelligence, Life Sciences & Biomedicine, Cutting-edge Engineering & Advanced Materials, Energy Efficiency, Quantum Technologies and Advanced Studies.

Table 4. MSc and PhD programs and student population

TARGET DOMAINS	MSc PROGRAMS	MSc STUDENTS	PhD PROGRAMS	PhD STUDENTS
Data Science & Artificial Intelligence	Data Science	130	Computational and Data Science and Engineering	61
	Computational Science and Engineering	27		
Life Sciences & Biomedicine	Biotechnology	83	Life Sciences	47
Cutting-edge Engineering and Advanced Materials	Space and Engineering Systems	53	Engineering Systems	69
	Advanced and Digital Engineering Technologies	19		
	Materials Science	22	Materials Science and Engineering	34
Energy Efficiency	Petroleum Engineering	24	Petroleum Engineering	27
	Energy Systems	19		
Quantum Technologies	Photonics and Quantum materials	29	Physics	27
Advanced Studies	Mathematical and Theoretical Physics	21	Mathematics and Mechanics	14
Total		427		279

The Agreement with the High Council for Evaluation of Research and Higher Education (France) signed to have Skoltech’s PhD programs accredited in accordance with EU standards

10 MSc programs,
7 PhD programs,
more than 170 curriculum courses

MSc degree requirements. All curriculum elements within the 2-year and 120 ECTS credit program are classified into streams, each with a focus on developing certain knowledge, skills and values:

- *Science, Technology and Engineering (STE) (36 ECTS credits),*
- *Sector (12 ECTS credits),*
- *Innovation and Entrepreneurship (E&I) (12 ECTS credits),*
- *MSc Project Research and Defense (MSc Thesis) (36 ECTS credits),*
- *Options (24 ECTS credits).*

PhD degree requirements. The duration of the PhD program is four years and the 240 ECTS credits are distributed between:

- *Research and Development (195 ECTS credits),*
- *Courses (30 ECTS credits, general doctoral courses – 18 ECTS credits, major-field courses – 12 ECTS credits),*
- *Pedagogical practice (6 ECTS credits),*
- *Final Assessment, including Thesis Defense (9 ECTS credits).*

Skoltech MSc and PhD programs blend fundamental knowledge with hands-on research, applications and entrepreneurship, providing Skoltech students with a real opportunity to construct their own learning trajectory from a wide choice of more than 170 curriculum courses. Also, all students are able to take learning activities outside the formal degree requirements, so-called extracurricular elements (*Fig.18*).

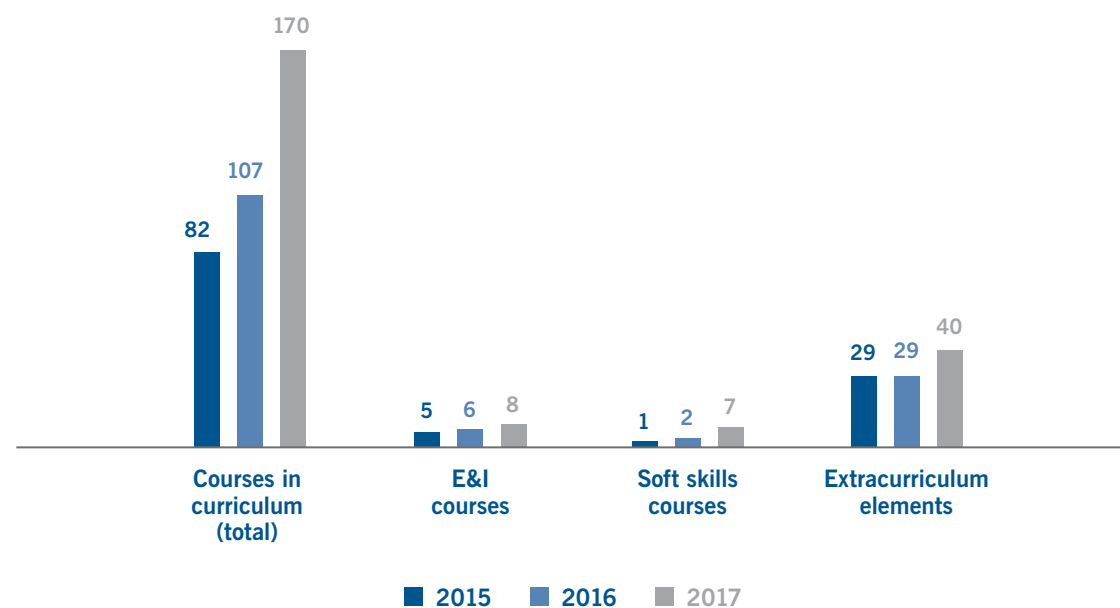


Figure 18. Skoltech courses

Table 5. E&I and “soft skills” courses within curriculum

#	COURSE TITLE	E&I / SOFT SKILLS
1	Innovation workshop	E&I
2	Technology Entrepreneurship	E&I
3	Innovation and Intellectual Property Studies Doctoral Seminar	E&I
4	Intellectual Property and Technological Innovation	E&I
5	Industrial Applications of Biomedical Science	E&I
6	Thinking Disruptive for Big Future	E&I
7	Ideas to Impact: Foundations for Commercializing Technological Advances	E&I
8	Technology Commercialization: Foundations for Doctoral Researchers	E&I
9	Academic Writing (Theory and Practice)	soft skills
10	History and Philosophy of Science. Candidate Examinations	soft skills
11	Philosophy of Science, Technology and Innovation	soft skills
12	Pedagogy of Higher Education	soft skills
13	Academic Communication	soft skills
14	English for PhD exam	soft skills
15	Academic English (for GUAP Students)	soft skills

Skoltech extracurricular offerings include such diverse courses as a lecture series on the “Four Metaphors for the Enlightenment” by Tatiana Smoliarova (Associate Professor, University of Toronto), “Science in Contemporary Art” by Stanislav Shpanin (visiting lecturer), “Negotiation Games” by Dmitry Kulish (Professor of Practice, Skoltech) and “Pilot School” led by students, as well as many others.

International Accreditation and Quality Assurance System. Skoltech plans to begin the international accreditation process in order to expand global recognition of its competitive academic programs. The Life Sciences PhD program will be the first educational program up for international accreditation. This pilot case will begin the assessment process for all graduate programs and Skoltech as an institution in accordance with the Standards and Guidelines for

Quality Assurance in the European Higher Education Area (ESG).

To satisfy the European standards, Skoltech must further develop its Quality Assurance System. Currently, this system has two components:

- Course evaluations and student feedback,
- Student academic performance, monitoring and analysis.

Course evaluations and student feedback. Skoltech regularly gauges the student learning experience, aiming to elicit feedback from 90% of students. The student response rate to course evaluations surged from 50% in 2016 to 88% in 2017. This is attributable to the introduction of an anonymous on-line survey, featuring short, action-oriented questions, for which students are allocated class time to complete.

More than **40%** of students participate in academic mobility, one-third opting for domestic mobility, two-thirds traveling internationally.

In addition, in 2017 the student survey results were shared with course instructors and program coordinators for purposes of quality improvement.

Academic Performance Monitoring and Analysis. Skoltech regularly analyses the academic performance of students in order to:

- Maintain high standards and requirements of academic performance,
- Provide feedback about the quality of the new student cohort,

- Analyze the complexity of the theoretical component and balance of the workload for students.

In addition, a particular focus is placed on academic integrity and ethical norms, which is an essential international standard. The Skoltech Disciplinary Board, which comprises representatives of various stakeholders – i.e. students, faculty members, and the educational and legal departments – makes administrative decisions aimed at improving the quality of education at Skoltech.

IMPLEMENTATION OF NEW TECHNOLOGIES AND PRACTICES TO EDUCATE CENTENNIALS (DIGITAL NATIVES) EFFICIENTLY

Recognizing the risk of reverting to and using old-fashioned and passive teaching techniques, Skoltech is taking active steps to embrace and develop new technologies and practices to educate centennials, including:

- Generating an inspiring atmosphere,
- Involving students actively in the learning process and research,
- Increasing the use of active teaching methods, such as “learning by doing” and “learning by teaching,”
- Encouraging a system of student mentorship, with a continuum of peers.

One of Skoltech key principles is to integrate education and science: in addition to course work, graduate students participate in research throughout their educational paths, starting from early research. In addition, Skoltech faculty members and experienced researchers both teach and engage in research, in order to foster excellence and creativity. All research laboratories provide research facilities for MSc and PhD students: Electrochemical Energy Storage Laboratory, IT for Advanced Manufacturing Laboratory, Concurrent Engineering Design Laboratory, Hybrid Photonics Laboratory, Enhanced Oil Recovery Laboratory, Intelligent Space Robotics Laboratory, Mass Spectrometry Laboratory, Energy Systems Laboratory, and Nanomaterials Laboratory.

Examples of putting these initiatives into practice include such courses as Product Lifecycle Management (PLM), the Innovation Workshop and the Independent Study Period (ISP), as well as Industrial Immersion and Academic Mobility.

PLM. One example of an active learning course is Product Lifecycle Management (PLM), taught by Prof. Igor Uzhinsky and lab instructor Sergei Nikolaev, utilizing the IT for Advanced Manufacturing Lab (ITAM). The “learning by teaching” and “learning by doing” principles are realized during the PLM course when MSc student teams, under the supervision of doctorates and research scientists, develop small unmanned aerial vehicle (UAV) with deployable wings. Advanced simulation and optimization tools (NX CAD, Simcenter 3D, LMS System Synthesis, LMS Amesim, ANSYS, STAR-CCM, LMS Test.Lab) are used in the educational process for creating a so-called “digital twin” of a real UAV and to achieve the continuity and transparency of the development process (Fig.19). The Siemens Teamcenter PLM system is used to manage requirements and changes, as well as to secure an ultimate result as a single unit. This course provides the opportunity for prospective engineers to trace the steps of a new product from idea to prototype: starting from requirements and constraints to a global, functional and detailed model, then testing all the components in static and dynamic conditions, and examining the final product in the end.

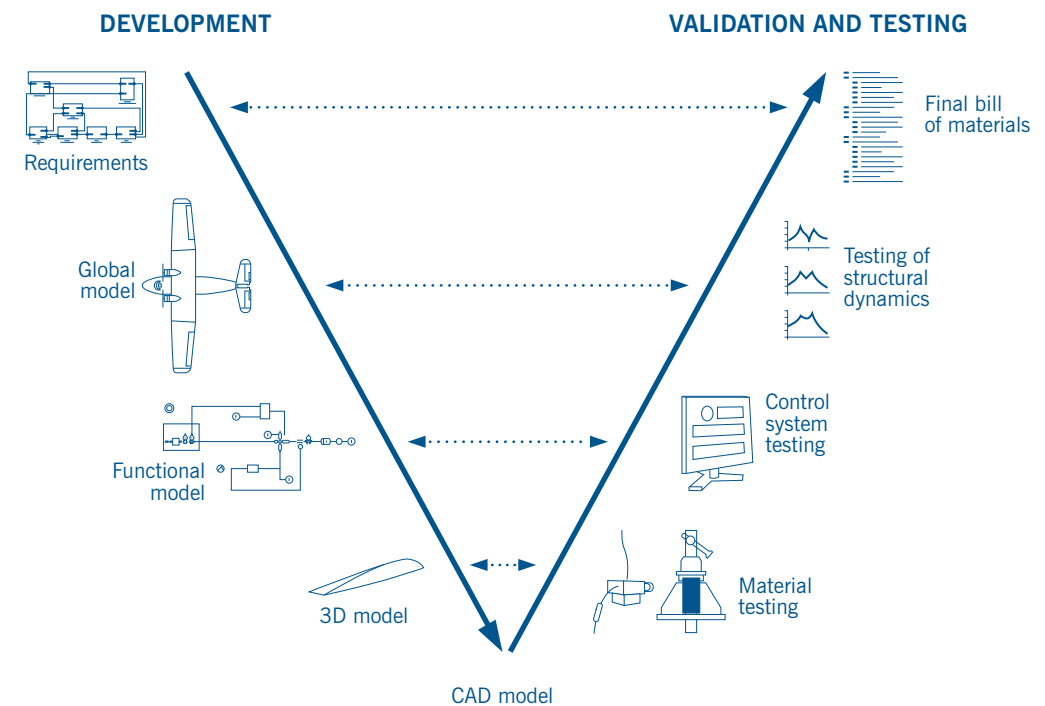


Figure 19. Product Lifecycle Management in ITAM Lab

The **Innovation Workshop** is an intensive course that takes place at the start of students' first term at Skoltech. It was designed to foster innovators, focusing on team work, group projects and sparking entrepreneurial instincts from the very first days of study. Participants in Innovation Workshop 2017 included 242 students divided among 47 team projects under the supervision of 40 mentors and instructors. More than 60 lectures and workshops were delivered by 105 professors and instructors from partner institutions.

ISP. Another unique practice in Russia is the Independent Study Period (ISP), which gives students the opportunity to create and attend interdisciplinary courses, allowing them to enhance and expand their knowledge and gain practical experience in the creation of innovative interdisciplinary projects.

During ISP 2017-2018, students and faculty members delivered more than 40

varied courses, allowing students to choose a more personalized educational trajectory. All members of the Skoltech community (i.e. students, faculty, postdocs, staff, alumni, etc.) were encouraged to create courses, seminars, workshops, etc. aimed at sharing their expertise, skills and interests with others, including ones not necessarily related to their day-to-day Skoltech roles. ISP is a time to learn new skills and ideas and to broaden the sense of Skoltech community.

Industrial Immersion. In 2017, there were 107 individual and group 2-month projects in 75 high-tech companies, co-supervised by Skoltech faculty and researchers (Table 6). The closing day of Industrial Immersion is “The Big Industry Day”. Students presented the final results of their immersion experiences to other students (MSc first and second year) and company representatives, at an event also attended by faculty and researchers. The best projects received awards.

Table 6. Companies involved in Industrial Immersion 2017

CREI	PROJECTS EXECUTED	COMPANIES
CDISE	40	Gazprom Neft, Kaspersky, United Aircraft Corporation, Rostelecom, Rusagro, SAS Institute, Sberbank, Yandex, ASANA, BCS Global Market, British Petroleum, Datadvance, Diginetica, Dr. Tariff, Google Research, Group-IB, Huawei, Minimax-94, Nivea, Piklema, S7, Samsung R&D, Vocord, Vision Labs, SIG Tuple, Sourced
CDMM	9	Inumit, Motorica, OKAN, InTouch, Organic Emitters, SIU Systems
CHR	7	Gazprom Neft, R&D, Zarubezhneft, MSU -Geophysics, NGT- Sintez
CES	4	Rosseti, MOEK Gazprom
CEE	2	Bosch, InEnergy
CPQM	8	IPG-Photonics, Russian Quantum Center, RTI, SMA, T8, Femto-Tech, Photonics nano-meta technologies
SC	14	Dauria, Sputnix, Airbus, C3DLabs, Gottfried Wilhelm Leibniz Universität, Purple Perch, RoboCV, Samsung
CDIBB, CTB	23	Agroplazma, Analytical Spectronomy, ATLAS, BIOCAD, RNA- Sintez, Sirius, ATPLabs Ltd, BioCubaFarma, Evogene, Generium, Genotek, InsideDNA, M&S Decisions, MiLaboratory, Philip Morris International R&D, TransAlga, Visual Science

Academic mobility. Recognizing that international collaboration and networking is a vital component of any modern, competitive institute of higher education, Skoltech provides every student with the opportunity to participate in academic mobility programs.

In 2017, 302 students (85 MSc and 217 PhD) received support for academic mobility (Fig.20), with approximately one-third going to domestic (Russia) destinations and two-thirds opting for international mobility trips.

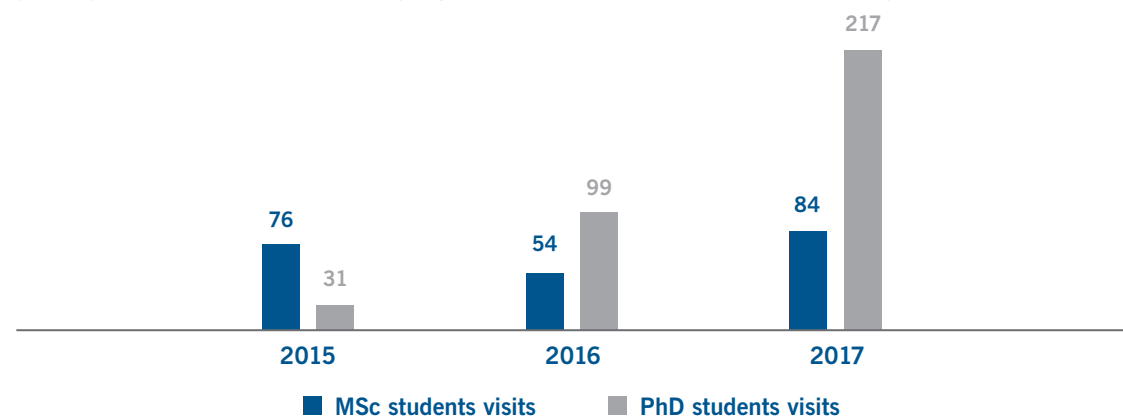


Figure 20. Academic mobility of MSc and PhD students

The purpose of academic mobility varies, from short-term trips, such as talks and presentations at conferences, seminars and competitions, to long-term academic mobility programs to conduct research and credit-bearing activities at leading universities. In 2017, MSc and PhD

students went on 237 short-term mobility trips and 65 students went on long-term trips.

For MSc students' long-term academic mobility primarily focuses on conducting research as part of thesis projects for a duration of between two and four months,

and for PhD students up to one year. Skoltech students have been placed at such leading international universities as: the Massachusetts Institute of Technology, the California Institute of Technology, the Delft University of Technology, Harvard

Medical School, the Karlsruhe Institute of Technology, the Max Plank Institute, the Pasteur Institute, the University of California, Berkeley, the University of Manchester, etc. The goal is to increase long-term academic mobility in 2020 to 30%, as a target KPI.

UNIQUE EDUCATIONAL ENVIRONMENT – “LEARNING COMMONS” INCLUDING DIGITAL ENVIRONMENTS

The Skoltech educational environment includes so-called Learning Commons – learning spaces on campus that integrate essential services, such as computing and library services, equipment and tools and work spaces. These spaces can be used for co-designing, tutoring, teamwork and individual study. Available 24/7, they are designed to encourage students to effectively engage in active learning.

Digital Learning Commons. The role of an e-library and virtual resources, digital tools, and eLearning to encourage a Digital Learning Commons, has significantly expanded in 2017.

The number of full text scientific databases available to students is constantly growing. This is reflected in the growth of full-text document downloads (*Table 7*).

At the moment, students have access to 14 universal and topic-specific scientific databases, including Science Direct, Springer and IEEE, as well as four bibliographic databases, in particular, Scopus and Web of Science, a patent database, Cipher.

In 2017, Skoltech, started to acquire e-books to enhance the student learning experience and ensure better access to its collection. Now students have access to e-book versions of most of the required books via course syllabi pages at Canvas.

The basic needs for a broader range of scientific literature are covered by the Springer e-books collection, which is provided by Russian Foundation for Basic Research grant.

Table 7. Learning Commons progress

#	COURSE TITLE	2015	2016	2017
1	Print books collection	200	400	700
2	E-books	0	0	220
3	Springer e-books provided by Russian Foundation for Basic Research grant	32 000	32 000	70 000
4	Full-text documents downloads from library databases	2 600	8 400	50 000

Software. In addition, Skoltech offers a large variety of standard software (e.g. MatLab), as well as granting students access to some of the newest professional software, such as OrCAD, SolidWorks Premium, Vic3D, HydraFLUSH, and Wolfram Research. This experience is valuable for future graduates.

Online course catalog. Unusual in Russia, an online course catalog contains the full syllabi of more than 170 courses and is now publicly accessible for all internal and external customers. To facilitate this process, an online syllabus form was developed and

launched, with automatic updates.

Page views of <http://www.skoltech.ru/en/education/> increased dramatically during the Fall term of 2017 in comparison with the previous Fall term (2016): 40,224 (22.45% of all page views www.skoltech.ru/), as compared with 12,157 (11%). The number of users who visited the education portal per day increased from 20-30 during the first half of the year to about 700 in November-December 2017 (Fig.21). These visible results demonstrates the relevance of the information available at <http://www.skoltech.ru/en/education/>.

• Unique Pageview

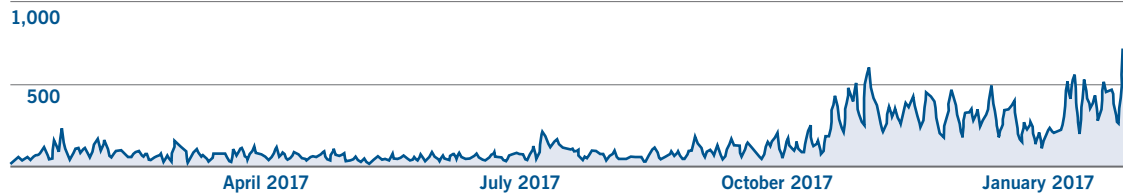


Figure 21. Unique page views of <http://www.skoltech.ru/en/education/> (2017)

Canvas LMS. New technologies also enable more effective management of the education process. In 2017, more than half of Skoltech courses used the Learning Management System Canvas as an essential part of the active learning

approach. Canvas is an instrument of teaching management and a useful self-study tool for students. The Education Department facilitates faculty who are not familiar with Canvas and provides on-line tutorials and face-to-face counselling.

GRADUATION AND PhD DEFENSES

In 2017, Skoltech graduated its third MSc cohort: 84 students received MSc diplomas, including 25 diplomas with distinction (Fig.22).

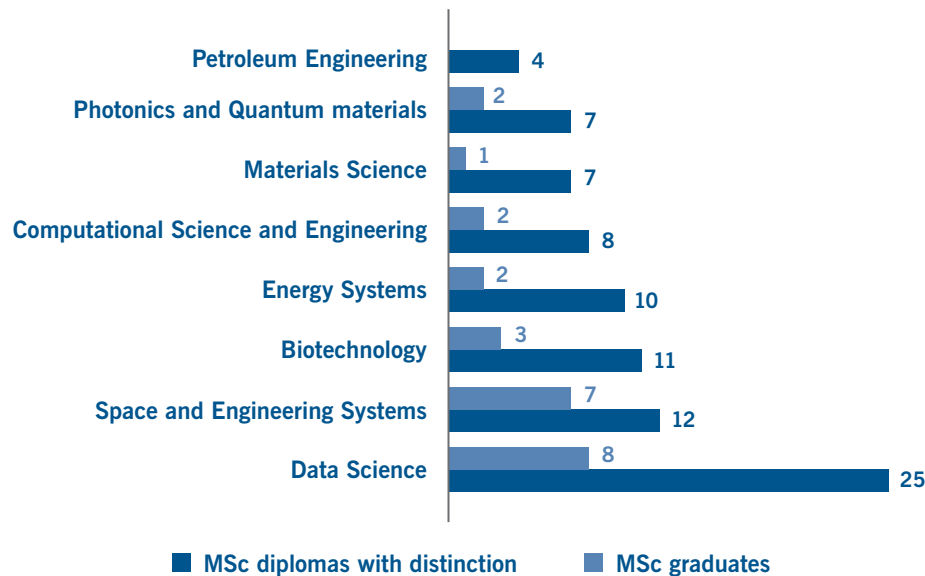


Figure 22. MSc graduates in 2017, by program

In 2017, the first eight PhD students graduated from Skoltech. All graduates fulfilled their requirements in accordance with Russian legislation and the standards for accredited (Aspirantura) programs, and received their state diploma. The Russian state Aspirantura diploma is not equivalent to the PhD degree, as the Aspirantura program does not include a

thesis defense. As Skoltech's mission is to adapt the best world practices for Russia, Skoltech has implemented an international system of awarding its own PhD degree. The PhD defense is an integral component of Skoltech doctoral program. Seven PhD graduates out of eight, successfully defended their theses and received Skoltech PhD degrees (Table 8).

Table 8. PhD graduates

PhD PROGRAMS	PhD GRADUATES (STATE "ASPIRANTURA" DIPLOMA)	PhD DEFENSES (SKOLTECH PhD DEGREE)
Life Sciences	5	5
Engineering Systems	1	1
Computational and Data Science and Engineering	2	1
Total	8	7

The PhD defense procedure at Skoltech is conducted in accordance with international practice. Each PhD Defense Jury consists of scientists with specific expertise relevant to the topic of the thesis. At least two of them are international experts, so as to strengthen the checks and balances in the evaluation of the integrity and quality of the thesis.

Members of the PhD Defense Juries were professors from outstanding, international universities, such as Delft University of Technology (Netherlands), Imperial College (London, United Kingdom), the Massachusetts Institute of Technology (MIT, United States), Tel Aviv University (Israel), etc. (Table 9).

Compared to other Russian institutes and universities, Skoltech holds its graduates to particularly stringent PhD defense requirements. The Institute requires at least two papers published in high-impact journals indexed in WoS and Scopus and at least two presentations at reputable international conferences. Skoltech PhD graduates have had publications in Science, Nature Reviews, the Journal of the American Chemical Society and other journals with high impact-factors.

Skoltech has a higher proportion of PhD graduates who have defended their dissertations than many leading Russian universities (87%).

Table 9. PhD defenses

#	PhD DEGREE GRADUATES	THESIS TITLE	SUPERVISOR	PhD DEFENSE JURY	
				MEMBER OF DEFENSE JURY	UNIVERSITY
LIFE SCIENCES					
1	Sergey Shmakov	Computational approaches for discovery of novel CRISPR-Cas systems	Prof. Konstantin Severinov (CDIBB)	Prof. Mikhail Gelfand, Chairman (CDIBB)	Skoltech
				Prof. Georgii Bazykin (CDIBB)	Skoltech
				Prof. Dmitri Pervouchine (CDIBB)	Skoltech
				Prof. Udi Qimron	Tel Aviv University
				Prof. Blake Wiedenheft	Montana State University
2	Olga Musharova	Investigation of DNA-binding specificity of Cas1-Cas2 CRISPR adaptation complex in <i>Escherichia coli</i>	Prof. Konstantin Severinov (CDIBB)	Prof. Philipp Khaitovich, (Chairman) (CDIBB)	Skoltech
				Prof. Petr Sergiev (CDIBB)	Skoltech
				D.Sc. Vsevolod Belousov	IBCh RAS
				Prof. Dmitri Chudakov (CDIBB)	Skoltech
				Prof. Blake Wiedenheft	Montana State University
				Prof. Udi Qimron	Tel Aviv University

#	PhD DEGREE GRADUATES	THESIS TITLE	SUPERVISOR	PhD DEFENSE JURY	
				MEMBER OF DEFENSE JURY	UNIVERSITY
3	Aleksandra Strotskaya	Effects of targeting by <i>Escherichia coli</i> I-E CRISPR-Cas system on infection by different phages	Prof. Konstantin Severinov (CDIBB)	Prof. Yuri Kotelevtsev, Chairman (CTB)	Skoltech
				Prof. Dmitri Papatsenko (CDIBB)	Skoltech
				Prof. Petr Sergiev (CDIBB)	Skoltech
				D.Sc. Kirill Miroshnikov	IBCh RAS, Moscow
				Prof. O. Soutourina	Paris-Sud University
				Prof. Stan Brouns	Delft University of Technology
4	Daria Artamonova	Comparative analysis of the action of eubacterial class 1 CRISPR-Cas systems	Prof. Konstantin Severinov (CDIBB)	Prof. Yuri Kotelevtsev, Chairman (CTB)	Skoltech
				Prof. Dmitri Papatsenko (CDIBB)	Skoltech
				Prof. Petr Sergiev (CDIBB)	Skoltech
				Prof. Timofey Zatsepin (CTB)	Skoltech
				Prof. Olga Soutourina	Paris-Sud University
				Prof. Stan Brouns	Delft University of Technology
5	Iuliia Piskunova	Maturation and functional analysis of microcin C-like compounds	Prof. Konstantin Severinov (CDIBB)	Prof. Yuri Kotelevtsev, Chairman (CTB)	Skoltech
				Prof. Dmitri Papatsenko (CDIBB)	Skoltech
				Prof. Timofey Zatsepin (CTB)	Skoltech
				Prof. Konstantinos Beis	Imperial College London
				Prof. Satish K. Nair	University of Illinois
COMPUTATIONAL AND DATA SCIENCE AND ENGINEERING					
6	Daniil Kononenko	Learnable warping-based approach to image re-synthesis with application to gaze redirection	Prof. Victor Lempitsky (CDISE)	Prof. Maxim Fedorov, Chairman (CDISE)	Skoltech
				Prof. Ivan Oseledets (CDISE)	Skoltech
				Prof. Stamatis Lefkimmiatis (CDISE)	Skoltech
				Prof. Dimitry Samaras	Stony Brook University
				Prof. Esa Rahtu	Tampere University of Technology
ENGINEERING SYSTEMS					
7	Ignasi Lluch I Cruz	A Framework for Architecting Federations of Engineering Systems	Prof. Alessandro Golkar (SC)	Prof. Clement Fortin, Chairman (SC)	Skoltech
				Prof. Rupert Gerzer (CTB)	Skoltech
				Prof. Zeljko Tekic (CEI)	Skoltech
				Prof. Olivier de Weck	MIT
				Prof. Heinz Stoewer	Delft University of Technology



The main priority for the immediate future will be the recognition of the Skoltech PhD degree in the Russian Federation. The Russian defense procedure for the Candidate of Science degree differs significantly from international practice. While there is widespread international recognition of the Skoltech PhD degree, it is not equivalent

to the Russian State Candidate of Science degree. In order to resolve this situation, Skoltech has drafted amendments to the Federal Law on the Skolkovo Innovation Center and the Federal Law on Science and Technological Policy, which would grant Skoltech the right to award a PhD degree that is also recognized in Russia.



ALEXANDER KULESHOV
President of Skoltech and Full Member of the Russian Academy of Sciences:
“Skoltech is a testing ground for implementing new technologies and practices to educate centennials.”

TRANSLATIONAL RESEARCH

The Skoltech Program for Translation Research and Innovation (STRIP) is a program to support research teams in establishing proof of concept and advancing technology towards commercialization; it aims at bridging the gap between research results obtained in the laboratory and their subsequent practical application in products or processes of interest to the real markets. The peculiarity of this program is its focus on supporting the translational research (innovative R&D) necessary for reducing this gap and minimizing the two main types of risks: technical and marketing. With respect to technical risks, the STRIP helps to ensure that innovative products and services meet the technological requirements of potential customers, while for marketing, it helps teams

analyze the availability of a relevant market segment or the possibility of its formation. Thus, the Program promotes applied research and motivates scientific teams to take risks and see if their developments are applicable to end-user markets.

In early 2017, seven projects were selected for support within STRIP (Table 10). These projects focus on addressing a variety of modern problems, such as the creation of promising materials for redox batteries, a robotic platform for warehouse automation, a platform for flexible online electronics, a portable wireless ECG device, a new type of marker for virtual reality systems, devices for ultrasonic applications, hydrocarbon field exploration technologies, and more.

Table 10. STRIP projects

PROJECT	PI
1. Flexible ultrasound module	Prof. Albert Nasibulin (CPQM)
2. Components for stretchable skin-like electronics	Prof. Albert Nasibulin (CPQM)
3. Development of a new method and technology for investigations of traditional and unconventional hydrocarbon reservoirs	Prof. Yuri Popov (CHR)
4. Magic carpets	Prof. Victor Lempitsky (CDISE)
5. CardioWave	Prof. Rupert Gertzner (CTB)
6. PickToGo	Prof. Dzmitry Tsetserukou (SC)
7. Advance Ion-exchange Membranes for Redox-flow batteries	Prof. Keith Stevenson (CEE)

Projects selected in 2017 to participate in Skoltech’s Program for Translational Research and Innovation were granted priority access to special training and services, as well as financial support to verify the feasibility of their ideas. Teams also received mentoring from leading experts and technology entrepreneurs to narrow the gap between the laboratory prototypes and the final product.

In 2017, Skoltech held two STRIP conferences to assess the development

dynamics of the selected projects: on May 25 and November 21. The conferences were attended by Skoltech’s faculty, representatives of the Skolkovo Foundation clusters, mentors and invited experts from industrial companies. In addition to conferences, project teams regularly meet with assigned mentors. These sessions help teams plan their further work towards the commercialization of the technologies or adjust their inventions to meet market needs. The STRIP program also facilitates visits of project teams to industrial companies.

Innovation Workshop

Educational courses that contain innovation component represent at Skoltech widely. The program “Innovation Workshop” developed specifically for Skoltech on the base of a similar MIT course by Skoltech jointly with MIT faculty has been a successful platform boosting entrepreneurship and innovation spirit, with a special curriculum focused on training all Skoltech students. One of the key tasks of this course is to teach students basic skills and practices to brainstorm innovative ideas and develop concepts of future innovations. Thus, during this training students go through the whole innovation process starting from generating and evaluating ideas following by their actual implementation in the

form of prototypes, receiving feedback from potential buyers, investors, possible partners in the industry, etc. In order to achieve greater results from the workshop, students are asked to create teams and work on their educational innovation projects during the course.

In 2017, more than 240 students attended the course. More than 60 lectures on entrepreneurship and innovations were conducted together with 19 parallel practical laboratory works for three days. 105 participant-lecturers from partner institutes and more than 40 mentors were invited to teach and mentor during innovation workshop. As the result, students prepared and presented 47 projects (prototypes and presentations).

UMNIK

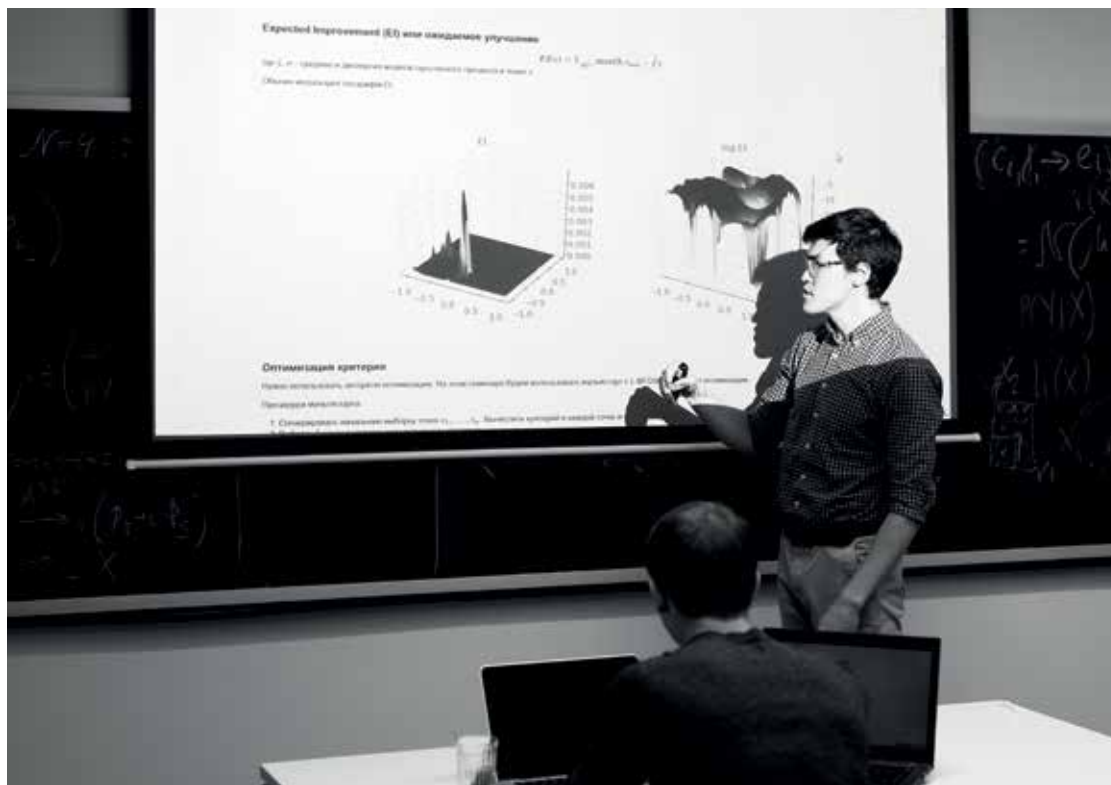
UMNIK is a federal program of the Foundation for the Promotion of Innovations to support young scientists. Each UMNIK grant amounts to 500,000 rubles and supports two years’ worth of research. For the third year in a row, Skoltech was accredited in 2017 to conduct the selection process for the program. The 2017 finals were held at the end of December in five areas: IT, future medicine, modern materials

and technologies for their creation, new devices and hardware complexes and biotechnologies.

In 2017, 67 applications were submitted for examination. Of those, 14 finalists were selected, who then presented their projects to a jury. More than 20 experts analyzed the potential commercial attractiveness of these projects, and as a result, eight projects were recommended for funding.

Value Generation

/03



Professional Training

The CDISE faculty members Prof. M. Fedorov, Prof. E. Burnaev delivered a professional training course in Data Analysis to two groups of Sberbank employees this year. Skoltech and Sberbank plan to further develop their cooperation.

Prof. A. Ivanov of the Space Center presented an advanced course in Systems Engineering for about 70 engineers from leading Russian industrial corporations,

including United Aircraft Corporation, United Engine Corporation and United Shipbuilding Corporation. The course was delivered jointly with the Moscow Aviation Institute (MAI) in the framework of the MAI Management School. It is planned to significantly expand such activities in 2018.

In total, Skoltech received 4.8 million RUB for its professional training activities in 2017.

Skoltech provided various advisory services, including:

- analytical support for governmental agencies and institutes seeking to develop scientific and technological policies;
- participation in expert panels and working groups formed for decision making in key areas of scientific and technological development;
- research, analysis and monitoring of scientific and technological areas;
- financial and economic analyses of new technological programs on request of the Russian Ministry of Education and Science;
- promotion and popularization of Skoltech achievements via participation in conferences and workshops, publications in mass media and scientific journals.

The major activities of the year included:

- active participation in key government and scientific initiatives, including “Digital Economy,” Scientific and Technological program “Photonics,” NTI Competence Centers, Strategy for implementation of R&D in the field of genome editing for the period 2017-2020 (Ministry and RVC),
- active participation and provision of expert support on initiating and developing NTI’s roadmaps and projects, i.e. NeuroNet, AeroNet, TechNet, FoodNet, EnergyNet;
- initiating and providing expert support in implementing intergovernmental BRICS activities related to technological and industry-oriented projects. The 1st BRICS

Working Group on Biotechnology and Biomedicine including Human Health and Neuroscience has been organized and hosted at Skoltech;

- organization of the work of the advisory committee of LLC Gazprom Neft NTC in the field of digital technologies with the involvement of leading industry companies (IBM, Intel, McKinsey, BCG, etc.);
- preparation and publication of the White Paper “Advanced technological direction in the oil and gas extraction industry” (Prof. Mikhail Spasennykh (CHR), Prof. Dmitri Koroteev (CHR), Prof. Artem Myasnikov (CHR), Prof. Andrei Osipov (CHR), Prof. Alexey Cheremisin (CHR));
- preparing regular policy briefs for various clients on instruments and policies of the government in planning and implementing its scientific-technological policy (e.g. legislation concerning Federal Research Centers, research mobility, working with the research diaspora, suggestions regarding the program for increasing international competitiveness of Russian universities (5top100), approaches to form consortia, development of international cooperation, university-industry relations, and market analyses of various technological areas),
- financial and economic justifications of new technological programs upon the request of the Ministry of Education and Science (photonics, supercomputer technologies, genome editing). As a result, the Ministry has initiated new calls for proposals and competitive programs in advanced manufacturing and photonics.



ALEXEY PONOMAREV

Vice President for Industrial Cooperation, Skoltech:

“In the autumn of 2017, we held “Industrial Day” for the first time. Such events allow students to get better understanding of modern industrial landscape, while helping businesses to engage the brightest students with useful skills. Skoltech relies that its students will bring best international competences to the industry.”



STANISLAV SMIRNOV
Skoltech Professor:

“Skoltech is closely linked to innovative sectors of the economy with practical applications of science. Naturally, a significant part of fundamental science has always been focused on application, but in the past 40 years, the period from development to application has shrunk significantly, and we would like universities to get involved.”

Expert groups with Skoltech participation:

“TechNet” of the National Technology Initiative (Skoltech leads the group)	Alexey Ponomarev, VP Industrial Cooperation Prof. Iskander Akhatov (CDMM) Dr. Dmitri Katalevskiy (Industry Group) Dr. Ivan Sergeichev (CDMM)
Working group on standards, direction “Legal regulations,” Digital Economy Program	Alexey Ponomarev, VP Industrial Cooperation Prof. Evgeny Burnaev (CDISE) Dr. Dmitri Katalevskiy (Industry Group) Prof. Ivan Oseledets (CDISE) Prof. Dmitri Koroteev (CHR) Dr. Mikhail Belyaev (CDISE) Dr. Alexander Bernstein (CDISE) Prof. Igor Uzhinskiy (CDMM) Prof. Dmitri Tzeterukou (SC) Prof. Arkady Chipouline (CPQM)
BRICS International Working group on Photonics	Prof. Arkady Chipouline (CPQM) Prof. Pavel Dorozhkin (CEI) Natalia Kosmodemianskaya (R&D Contract Office)
BRICS International Working Group on Biotechnology and Biomedicine including Human Health and Neuroscience	Prof. Philipp Khaitovich (CDIBB) Timur Gareev (Industry Group) Natalia Kosmodemianskaya (R&D Contract Office)
Russian Interagency Council on scientific, technological and innovative cooperation within the framework of BRICS (Working group on developing priorities for BRICS science, technology, and innovation collaboration)	Alexey Ponomarev, VP Industrial Cooperation Natalia Kosmodemianskaya (R&D Contract Office)
Working Group on Cyber-physical systems in Rosstandart	Alexey Ponomarev, VP Industrial Cooperation Prof. Iskander Akhatov (CDMM)
Working Group of the Presidential Administration on International Scientific Cooperation (initial establishment)	Irina Dezhina (Research & Industrial Policy Group)
Working group of the Ministry of Education and Science on interactions with Russian-Speaking Research Diaspora	Irina Dezhina (Research & Industrial Policy Group)
Working Group of the Presidential Administration on the scientific communication and popularization of science	Irina Dezhina (Research & Industrial Policy Group)

Industry Funded Research

In 2017, Skoltech established contacts with more than 300 companies (including small and medium-sized technological and innovation businesses). There were ongoing projects with more than 40 large and medium-sized companies (Gazprom Neft, Sberbank, Rusagro, Biocad, Soyuzsnab, Agroplazma, ISS Reshetnev and others), negotiations on R&D projects held with Rostelecom, MMK, Severstal, S7, Atomstroieksport, Rosatom, IBS, Soyuzsnab, Datadvance, Yandex, Novostom, Slavneft, AKADO, UAC, Soevvy Kompleks, Generium, Doka Gene technologies, EN Energy and others). Negotiations were held with foreign companies, including Samsung, Bosch, Phillips, IPG Photonics and ENEL. Partnerships were developed with leading consulting companies and IT vendors including IBM, SAS, Deloitte & Touche and KMPG.

An example of establishment of strategic cooperation was the development of a complex program which addresses Gazprom Neft’s needs in oil and gas-related areas (including 6 R&D contracts for a total of 72 million rubles), which launched discussion of more than 10 additional proposals, including the allocation of funding for the period 2018-2019 for more than 90 million rubles. The Skoltech R&D Contract Office provided legal and administrative support for developing proposals/contracts and 45 industry-oriented projects including complex projects for a total of 424,8 million rubles. Skoltech signed 50 new contracts with industrial partners amounting to a total of 671 million rubles in funding (contracts period 2017-2019).

PROJECT PRINCIPAL INVESTIGATOR	INDUSTRY FUNDED SUPPORT
DATA SCIENCE AND AI	
Prof. Maxim Fedorov (CDISE)	46.7 mln RUB (Aeronet NTI)
Prof. Evgeny Burnaev (CDISE)	13.0 mln RUB (Sberbank, Ministry subsidies)
Prof. Alexey Frolov (CDISE)	7.0 mln RUB (HUAWEI)
Prof. Ivan Oseledets (CDISE)	6.0 mln RUB (HUAWEI)
Prof. Victor Lempitsky (CDISE)	1.6 mln RUB (Vision Labs)
Prof. Dmitri Lakontsev (CDISE)	1.0 mln RUB (New Engineering Technologies)
LIFE SCIENCES	
Dr. Maria Logacheva (CDIBB)	30 mln RUB (Ministry subsidies)
Prof. Konstantin Severinov (CDIBB)	60 mln RUB (Ministry subsidies)
Prof. Philipp Khaitovich (CDIBB)	32.5 mln RUB (Ministry subsidies)
CUTTING-EDGE ENGINEERING AND ADVANCED MATERIALS	
Prof. Ighor Uzhinsky (CDMM)	47.0 mln RUB (Maloe Konstruktorskoe Buro, Analytical Center)
Prof. Dzmitry Tsetserukou (SC)	1.9 mln RUB (Zelenye Linii JSC)
ENERGY EFFICIENCY	
Prof. Mikhail Spasennykh (CHR)	88.5 mln RUB (Lukoil Engineering, Gazprom Neft, TOTAL E&P RECHERCHE DEVELOPPEMENT, Tomsk NII Neft, Zarubezhneft, VNII Neft, Technopark of Gubkin University)
Prof. Andrei Osiptsov (CHR)	86.6 mln RUB (Ministry subsidies, Gazprom Neft)
Prof. Dmitri Koroteev (CHR)	41.3 mln RUB (Gazprom Neft R&D, Expert RP JSC)
Dr. Natalia Bogdanovich (CHR)	26.4 mln RUB (Lukoil Engineering, Novatek)
Dr. Dmitri Titov (CES)	13.0 mln RUB (Map Maker, MRSK Urala)
Prof. Alexey Cheremisin (CHR)	1.8 mln RUB (National Intellectual Development Foundation)
Dr. Stanislav Ursegov (CHR)	1.7 mln RUB (ISKANDIA Energy Operating)
QUANTUM TECHNOLOGIES	
Prof. Ildar Gabitov (CPQM)	77.0 mln (Ministry subsidies)
Prof. Vladimir Drachev (CPQM)	75.0 mln (Ministry subsidies)
Prof. Pavlos Lagoudakis (CPQM)	13.0 mln (Ministry subsidies)

Ongoing projects with more than **40** large and medium-sized Russian and international industrial companies.

50 new contracts signed in 2017 for a total of **671** mln RUB

Projects ongoing in 2017

Skoltech is working on industry-funded research under the contracts with Lukoil, Lukoil Engineering, Huawei, Schlumberger, NOVATEK, RusAgro Group, Vision Labs, TOTAL E&P RECHERCHE DEVELOPPEMENT, Gazprom Neft R&D Center, Sberbank, Biocad, Geoskan, Zarubezhneft, Tymen R&D Center, Soyuzsnab, Scientific Production

Association KvinTech, Rosseti, Chemexpert, and Agroplazma. The institute has also launched interactions with industry leaders in the fields of digital technologies (Intel, IBM, KPMG, E&Y IoT Center of Excellence, Deloitte Big Data Institute, SAS, Borlas, ICore, etc.). In total, industry research funds contracted for 2017 amounted to 424.8 million RUB (Fig.23).

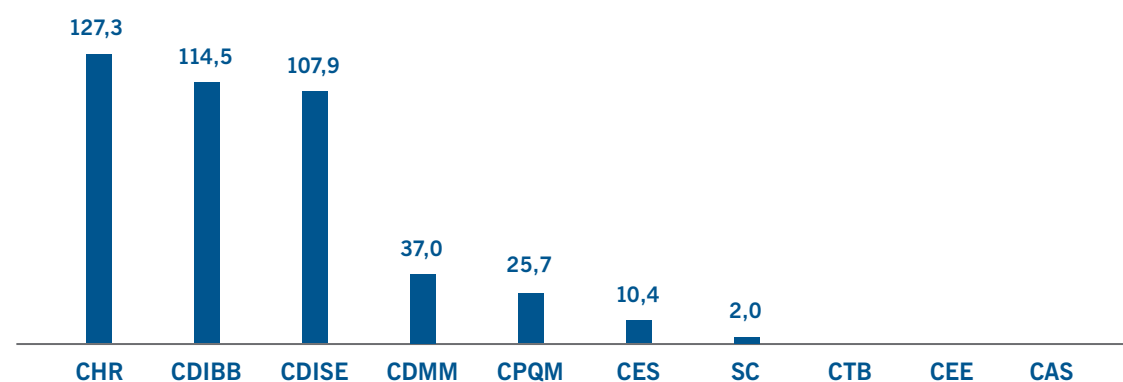


Figure 23. Industry funding contracted by CREI, 2017 (mln RUB)

Trends in industry funded research

The tables and charts below depict trends in attracting industry funds during the period of 2015-2019.

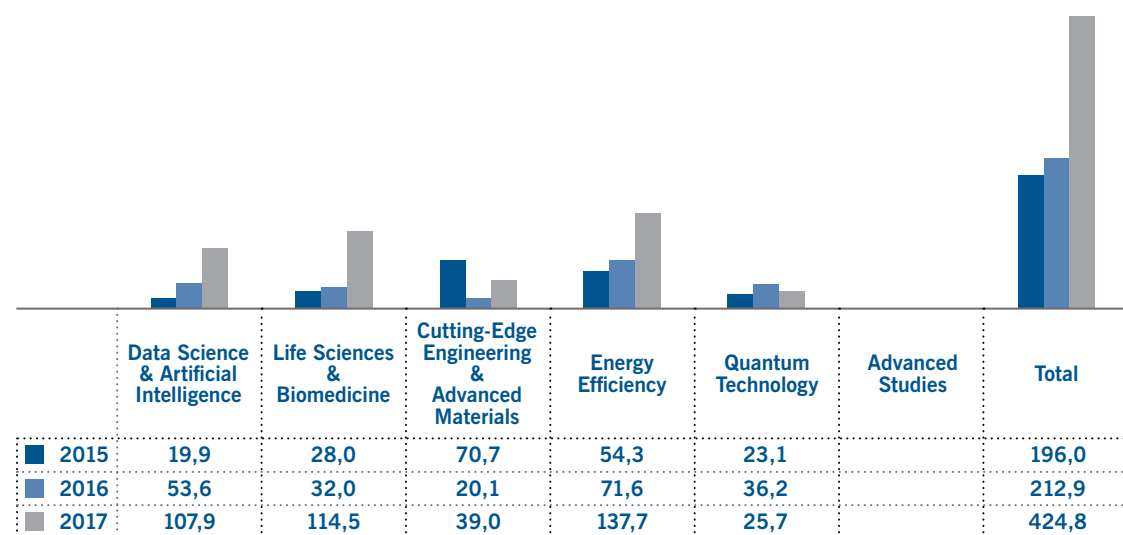


Figure 24. Industry funding in 2015-2017 by target domain (mln RUB)

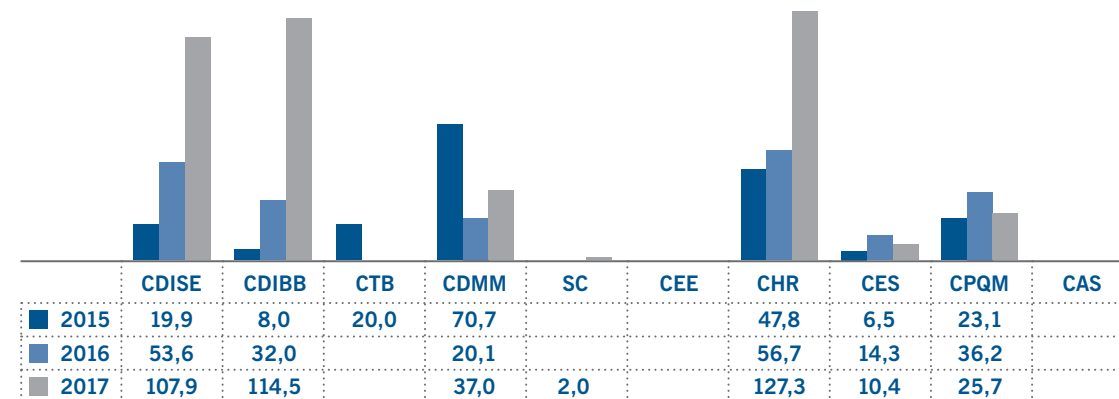


Figure 25. Industry funding in 2015-2017 by CREI (mln RUB)

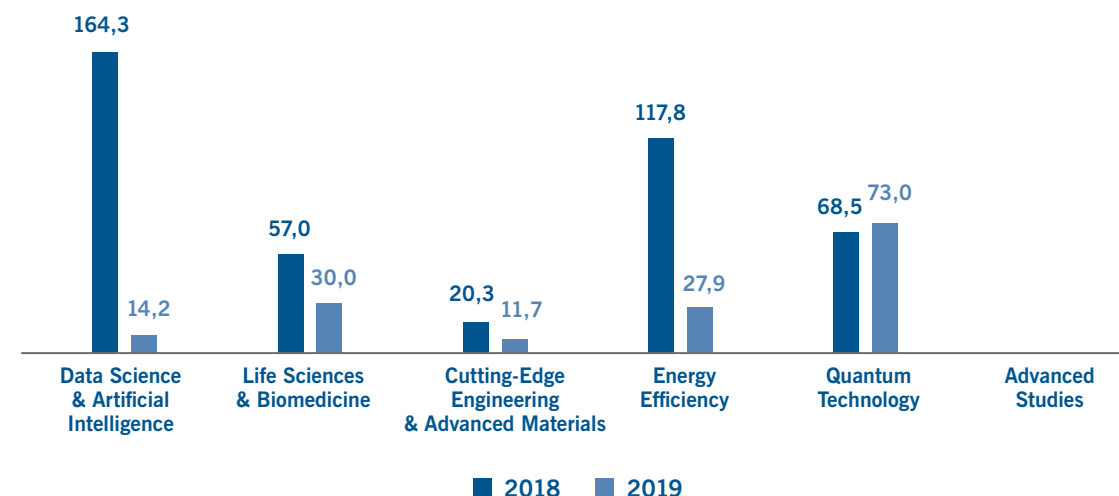


Figure 26. Industry funding contracted for 2018-2019 by target domain (mln RUB)

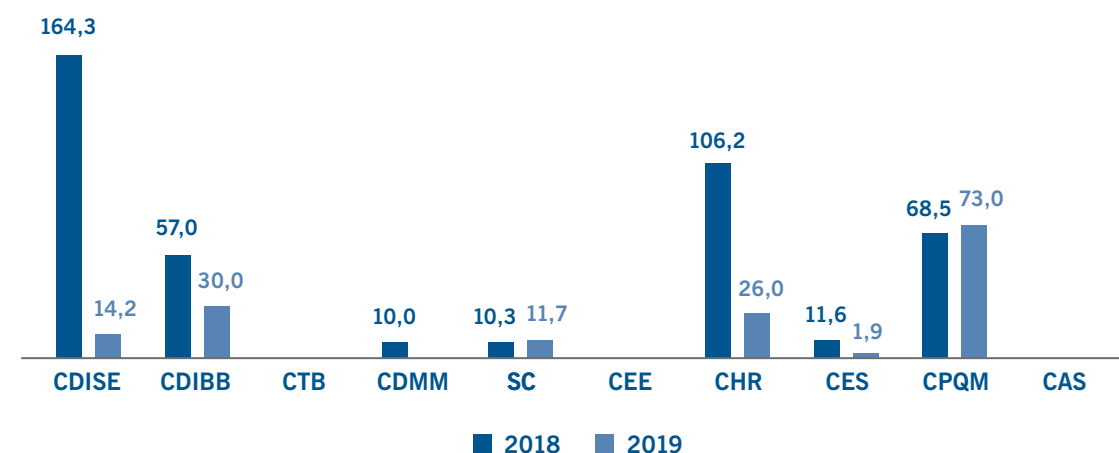


Figure 27. Industry funding contracted for 2018-2019 by CREI (mln RUB)

Industry Partnership Network

Development of a Partnership Network is a crucial focus of the Department for Industrial Cooperation. Relevant efforts have included finding proper potential partners, establishing contacts, defining areas of mutual interests and making commercial proposals, resulting in some cases with contracts. The sales funnel of such activities is significantly narrowing down. Accordingly, the Department for Industrial Cooperation has set its sights on about 300 companies, and is constantly expanding its network. The key value, which the Department is trying to bring in, is building trust in its relationships with its partners. This requires a lot of effort and sales skills, as leading and

managing negotiations between industry and professors or students is a multicomponent and complexly structured activity. Toward that end, the Department is playing the critical role of a buffer, smoothing and streamlining the process. With the help of active PR efforts, Skoltech has organized seminars for members of industry on a range of topics (agrotechnology, genome editing, computer vision for retail, machine learning, digital kernel, etc.) (Table 11); more than 35 companies and 150 participants have taken part in these seminars. These initiatives have helped to strengthen Skoltech partnership with industry and to launch several R&D projects.

Table 11. Seminars for industry held in 2017

TOPIC	SKOLTECH SPEAKERS	DATE
Machine learning for optimization of hydrocarbon exploration and production processes"	Prof. Dmitri Koroteev (CHR) Prof. Andrei Osipsov (CHR) Prof. Alexey Cheremisin (CHR) Prof. Maxim Fedorov (CDISE) Prof. Evgeny Burnaev (CDISE) Prof. Ivan Oseledets (CDISE) Prof. Yuri Popov (CHR) Prof. Victor Lempitsky (CDISE)	23-24 January 2017
Machine Learning	Prof. Dmitri Koroteev (CHR) Prof. Evgeny Burnaev (CDISE) Prof. Victor Lempitsky (CDISE)	31 January 2017
Genomic editing with CRISPR / Cas systems: limitations, new approaches and applications"	Prof. Konstantin Severinov (CDIBB)	27 February 2017
Genomic selection of plants: technologies and possibilities for practical application	Prof. Philipp Khaitovich (CDIBB)	28 February 2017
Computer vision is a new breakthrough technology for retail	Prof Victor Lempitsky (CDISE) Dr. Pavel Boyko (CDISE)	13 April 2017
RNA interference in vivo: opportunities of post-genome technologies for medical applications	Prof. Yuri Kotelevtsev (CTB) Prof. Timofey Zatsepin (CTB)	20 April 2017
Mutations in pluripotent stem cells and pluripotency genes	Prof. Dmitri Papatsenko (CDIBB)	18 May 2017
Internet Initiatives Development Fund (IIDF) and Skoltech: opportunities for collaboration	Prof. Evgeny Burnaev (CDISE) Prof. Victor Lempitsky (CDISE) Prof. D.Lakontsev (CDISE)	13 June 2017
CoBrain-Analytics platform: opportunities to work with big medical data	Prof. Philipp Khaitovich (CDIBB) Dr. Mikhail Belyaev (CDISE)	28 September 2017
Seminars on digital kernel and machine learning	Prof. Dmitri Koroteev (CHR) Prof. Evgeny Burnaev (CDISE) Prof. Andrei Osipsov (CHR) Dr. Alexey Zaytsev (CDISE) Dr. Leila Ismailova (CHR)	17 October 2017
Machine learning and its industrial applications	Prof. Evgeny Burnaev (CDISE) Prof. D.Lakontsev (CDISE)	2 November 2017
Projected achievements from related branches of science and technology, potentially applicable in aircraft engine building	Prof. Igor Uzhinsky (CDMM) Dr. Oleg Aladyshev (CDMM)	15 November 2017

In addition, about 30 policy briefs were prepared and provided for governmental bodies, institutes for development and other clients, including Skoltech leadership.

The table below presents the list of Skoltech affiliated patent applications submitted by faculty, researchers and students during the period of 2015-2017.

Table 12. Skoltech patent applications during 2015-2017

#	TITLE	SKOLTECH AUTHORS	TYPE	YEAR	STATUS
1	Method for correction of the eyes image using machine learning and method for machine learning	Prof. Victor Lempitsky (CDISE), Daniil Kononenko (CDISE)	Russian	2015	granted
2	An infrared radiation detector based on single-layer carbon nanotubes and graphene	Prof. Albert Nasibulin (CPQM), Dr. Yuri Gladush (CPQM) Alexandra Gorkina (CPQM), Evgenia Gilstein (CPQM), Aleksey Tsapenko (CPQM)	Russian	2015	granted (expired, not extended)
3	Learnable visual markers and methods of their production	Prof. Victor Lempitsky (CDISE)	Russian	2016	not granted
4	A program for calculating static stability of electric power networks based on inverters with adjustable frequency and voltage	Dr. Petr Vorobiev (CES)	Russian	2016	granted
5	Marking additive	Prof. Albert Nasibulin (CPQM) Dr. Anastasia Goldt (CPQM)	Russian	2016	granted
6	An extruder for additive manufacturing of products from composite materials	Dr. Andrey Azarov (CDMM) Dr. Fedor Antonov (CDMM) Dr. Mikhail Golubev (CDMM) Dr. Alexey Khaziev (CDMM)	Russian	2016	granted (rights assigned)
7	A method of producing thin films using carbon nanomaterials	Prof. Albert Nasibulin (CPQM) Dr. Anastasia Goldt (CPQM)	Russian	2016	not granted
8	Method For Correction Of The Eyes Image Using Machine Learning And Method For Machine Learning	Prof. Victor Lempitsky (CDISE) Daniil Kononenko (CDISE)	International	2016	published: WO 2016/153389

22 Russian and international patent applications filed in 2015-2017

#	TITLE	SKOLTECH AUTHORS	TYPE	YEAR	STATUS
9	Adaptive Indexing over Encrypted Numeric Data	Prof. Panagiotis Karras (CDISE) Artyom Nikitin (CDISE)	International	2016	published: WO 2017/ 222407
10	A method of recognizing objects defined by clouds of points	Prof. Victor Lempitsky (CDISE) Roman Klovov (CDISE)	Russian	2017	not granted
11	Learnable visual markers and methods of their production	Prof. Victor Lempitsky (CDISE)	International	2017	not published
12	A program for modeling an electric power network operating under direct decentralized perturbation-based control	Oleg Khamisov (CES)	Russian	2017	granted
13	A program for solving electric network power flow equations	Ali Mazhar (CES)	Russian	2017	granted
14	A database of oil crops genotypes	Prof. Philipp Khaitovich (CDIBB) Dr. Denis Goryunov (CDIBB) Dr. Svetlana Goryunova (CDIBB) Dr. Anna Pavlova (CDIBB)	Russian	2017	granted
15	Selective tone reservation for papr reduction in wireless communication systems	Prof. Dmitry Lakontsev (CDISE) Dr. Andrey Ivanov (CDISE)	International	2017	not published
16	A thin-film solar cell based on a heterojunction and a method of its production	Prof. Albert Nasibulin (CPQM) Pramod Malbagal Rajanna (CPQM)	Russian	2017	not granted
17	A chalcon sulfonyl halides synthesis method	Dr. Oleg Lukin (CDMM) Dmitry Semyonok (CEE)	Russian	2017	not granted
18	Magnetic materials	Prof. Artem Oganov (CEE) Rahmanian Koshkaki Saeed (CEE)	Russian	2017	not granted

#	TITLE	SKOLTECH AUTHORS	TYPE	YEAR	STATUS
19	New materials for cutting surfaces, specifically, drill bit teeth	Prof. Artem Oganov (CEE) Dr. Alexander Kvashnin (CEE) Prof. Andrey Osipsov (CHR) Dr. Leila Ismailova (CHR)	Russian	2017	not granted
20	Virtual reality systems based on a smartphone and an inclined mirror	Prof. Victor Lempitsky (CDISE)	Russian	2017	not granted
21	Database of reference sequences of the plants' ITS1 and ITS2 DNA markers	Dr. Maria Logacheva (CDIBB) Dr. Kamil Khafizov (CDIBB) Andrey Aiginin (CDIBB) Dr. Anna Speranskaya (CDIBB)	Russian	2017	granted
22	Substituted 1,2,4-oxadiazoles as modulators of the receptor-associated receptor 1 (TAAR 1)	Prof. Raul Gainetdinov (CTB)	Russian	2017	not granted



At its foundation, Skoltech is an academic institute committed to applied research and to the commercialization of its best ideas. Its commitment is manifested through all of the aforementioned activities and by the commitment of its faculty. Below is a list of ideas that evolved into commercially viable products and services. These ideas were developed by students, professors and researchers or by a combination of these individuals.

List of Skoltech startups 2015-2017

STARTUP	FOUNDERS	YEAR ESTABLISHED
Image Airy	Ekaterina Kotenko-Lengold (SC)	2014
MIG	Dr. Dmitri Titov (CES)	2014
Tardis (Skolkovo resident)	Vahe Taamazyan (CDMM)	2015
Neuroseti Ashmanova	Stanislav Ashmanov (CDISE)	2015
Anisoprint	Dr. Fedor Antonov (CDMM) Dr. Alexey Khaziev (CDMM)	2015
Tsuru Robotics	Nikita Rodichenko (SC)	2015
Suprematic-Razvitie	Anatoly Dymarski (ES)	2015
Lexy	Roman Zhukov (SC), Dmitry Suvorov (SC)	2016
Inspector Cloud	Pavel Boyko (CDISE)	2016
Komarik	Dmitry Vasilyev (CDISE)	2016
Rustor	Prof. Keith Stevenson (CEE), Prof. Artem Abakumov (CEE)	2017
CardioLog Technologies	Natalia Glazkova (CTB)	2017
Cryptochemistry	Prof. Albert Nasibulin (CPQM)	2017
Morphing Technologies	Yevgeny Erhan (CDISE)	2017

Human Capital

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Academic Staff

Faculty recruitment

In 2017, 24 faculty members joined Skoltech. In accordance with the Faculty Appointment, Promotion and Tenure Policy and Procedure established by the Academic Council, faculty appointments were primarily made following a search (open competition) process or a targeted hiring of internationally renowned scientists.

To attract high caliber candidates, various recruitment channels were applied, including posting advertisements in specialized media (Nature, New Scientist, MathJobs, Jobs.ac.uk, Academic Keys, Academic positions, etc.), and advertising open positions on the

Skoltech website and on Skoltech faculty academic networks.

In 2017, 109 candidates applied for various positions. Each application was reviewed by one of the Expert Panels established by the Appointment, Promotion and Tenure Committee of the Academic Council (APTC). Of these applicants, 36 candidates with strong international backgrounds were invited to Skoltech for research presentations and interviews with Skoltech faculty and leadership. Ultimately, 31 candidates were recommended for review and appointment to the APTC, and of those, 24 candidates were appointed as faculty members.

PROFESSOR	POSITION	FTE	PREVIOUS AFFILIATION
DATA SCIENCE & ARTIFICIAL INTELLIGENCE			
Dmitry Dylov	Assistant Professor, CDISE	1,0	Princeton University, United States
Gonzalo Ferrer	Assistant Professor, CDISE	1,0	University of Michigan, United States
Andrey Somov	Assistant Professor, CDISE	1,0	University of Exeter, United Kingdom
Jacob Biamonte	Associate Professor, CDISE	1,0	University of Malta, Malta
Dmitry Lakontsev	Associate Professor of the Practice, CDISE	1,0	Skoltech, Russia (<i>promotion</i>)
Alexey Vishnyakov	Associate Professor, CDISE	1,0	Rutgers University, United States
Nikolay Brilliantov	Full Professor, CDISE	1,0	University of Leicester, United Kingdom
CUTTING-EDGE ENGINEERING AND ADVANCED MATERIALS			
Alexander Pasko	Full Professor, CDMM	1,0	Bournemouth University, United Kingdom
Sergey Abaimov	Assistant Professor, CDMM	1,0	Skoltech, Russia (<i>promotion</i>)
Oleg Vasilyev	Full Professor, CDMM	1,0	University of Colorado Boulder, United States
Anton Ivanov	Associate Professor, SC	1,0	Ecole Polytechnique Fédérale de Lausanne, Switzerland
Jean-François Geneste	Associate Professor of the Practice, SC	0,3	Airbus Group, France
ENERGY EFFICIENCY			
Elena Gryazina	Assistant Professor, CEE	1,0	Skoltech, Russia (<i>promotion</i>)
Alexey Cheremisin	Associate Professor of the Practice, CHR	1,0	Skoltech, Russia (<i>promotion</i>)
Dmitry Eskin	Full Professor, CHR	1,0	Schlumberger-Doll Research Center, United States

PROFESSOR	POSITION	FTE	PREVIOUS AFFILIATION
QUANTUM TECHNOLOGY			
Vladimir Antonov	Associate Professor, CPQM	0,5	Royal Holloway, University of London, United Kingdom
Arkadi Chipouline	Associate Professor, CPQM	1,0	Technical University of Darmstadt, Germany
Dmitry Gorin	Full Professor, CPQM	1,0	Saratov State University, Russia
ADVANCED STUDIES			
Andrei Okounkov	Full Professor, CAS	0,4	Columbia University, United States
CEI			
Pavel Dorozhkin	Associate Professor of the Practice	0,3	NT-MDT Co., Russia
Maxim Kiselev	Associate Professor of the Practice	0,4	“Novy Disk” Group of Companies., Russia
Dmitry Kulish	Full Professor of the Practice	0,4	Drug Development.Ru., Russia
Alexey Nikolayev	Full Professor of the Practice	0,4	Intel Technologies., Russia
Eric Achtmann	Associate Professor of the Practice	0,25	Global Capital Advisors LLC

As of the end of the year, Skoltech has 104 faculty members. The composition of faculty by rank as well as distribution between the CREIs and target domains is presented in the figures below.

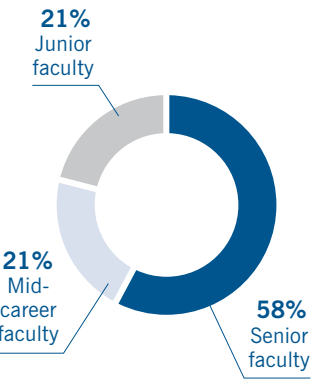


Figure 28. Skoltech faculty by rank (2017)⁸

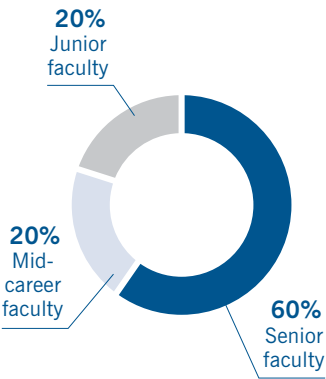


Figure 29. Skoltech faculty by rank (2016)

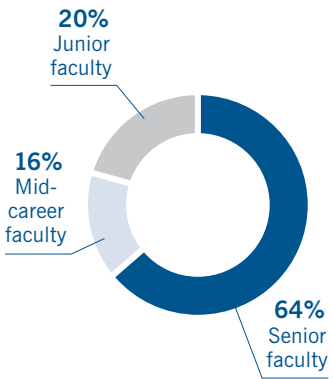


Figure 30. Skoltech faculty by rank (2015)

⁸ Senior faculty (full professors, professors of the practice, adjunct professors), mid-career faculty (associate professors, associate professors of the practice), junior faculty (assistant professors).

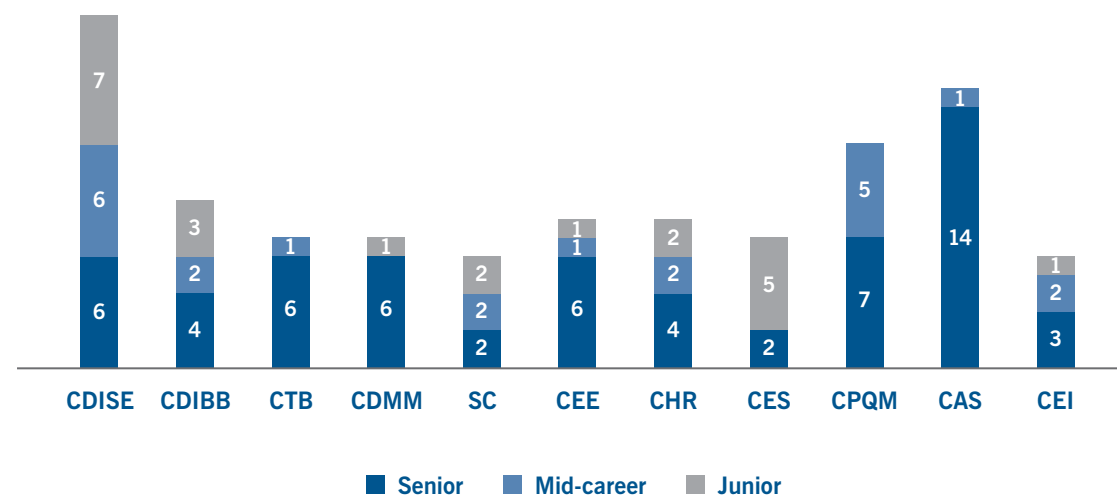


Figure 31. Faculty composition in 2017 by rank and CREI (incl. CEI)

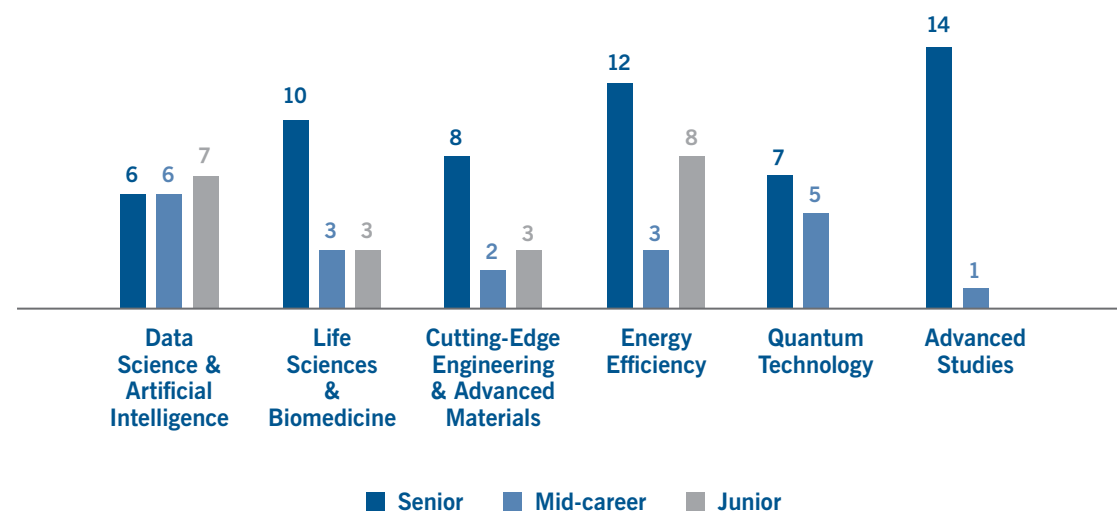


Figure 32. Faculty composition in 2017 by rank and target domain

RESEARCHERS

Skoltech continues to attract and develop high-performing researchers. In 2017, 72 new researchers joined CREIs and more than 50% of current research personnel renewed their

contracts. As of the end of 2017, Skoltech's research staff comprised 56 research scientists and 128 postdocs. The distribution of research staff is presented in the figures below.

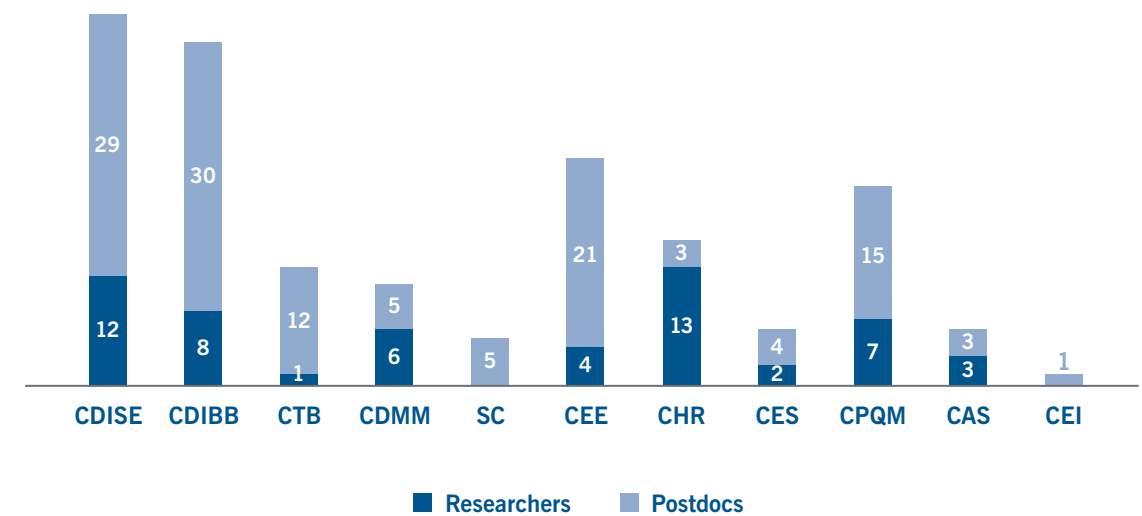


Figure 33. Researchers in 2017 by CREI (incl. CEI)

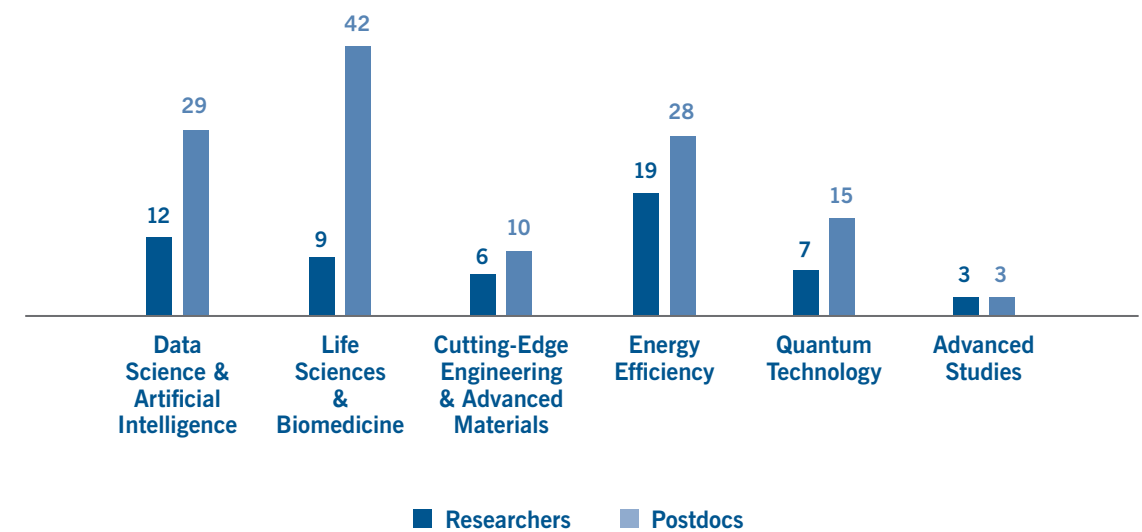


Figure 34. Researchers in 2017 by target domain

In 2017, Skoltech researchers initiated and organized an international cross-disciplinary Gen-Y conference for young scientists in Sochi. MSc and PhD students gathered alongside postdoctoral researchers and young professors from Skoltech's various CREIs for four days of lectures, seminars, poster sessions and fun.

Attendees were able to share their research and forge new partnerships. There were 73 participants, as well as a host of organizers and invited speakers. The conference was a great success and the organizers expressed hope that it will become an annual event, focusing on inspiring and recognizing research excellence.

FACULTY EXCHANGE AND VISITING PROGRAMS

Throughout 2017, Skoltech faculty members maintained academic collaborations with MIT, in particular through the Next Generation Program. This program supported 19 research projects that included a regular faculty exchange through remote communications and site visits.

Skoltech faculty also maintained a significant number of exchanges with other international and Russian universities, mainly through collaborative research projects.

COLLOQUIA

As shown below, Skoltech colloquia have attracted a number of exceptional speakers that presented new perspectives in research and innovation. In some cases, these events have enabled to attract top candidates to Skoltech faculty positions. In all cases, the colloquia provided ideal occasions for scientific exchanges that increased Skoltech visibility in international circles.

Table 13. Colloquia in 2017

COLLOQUIA	SPEAKER	AFFILIATION	DATE
Quantum materials: insights from near field nano-optics	Dmitri Basov	Higgins Professor of Physics, Columbia University, United States	January 31, 2017
ESA Future missions and Technologies	Franco Ongaro	Director of Technical and Quality Management at European Space Agency (ESA), ESA	March 16, 2017
Advanced Electron Microscopy of Advanced Materials	Gustaaf Van Tendeloo	Professor, Director of Electron microscopy for materials science (EMAT), University of Antwerp, Belgium	April 18, 2017
Breakthroughs Towards Aerospace Leadership	Jean-François Geneste	Vice-President – Chief Scientist at Airbus Group Innovations, Toulouse, France	May 18, 2017
Advanced Electron Microscopy of Advanced Materials	Van Tendeloo	Professor, University of Antwerp, Belgium	April 17, 2017
First-principle study of phosphors for white-LED applications: light absorption and emission, Stokes shift and thermal quenching	Xavier Gonze	Professor, Université Catholique de Louvain	October 2-3, 2017

In addition, colloquium (seminars) sessions are arranged by the CREIs. See, for example, open seminars of the CAS (<http://crei.skoltech.ru/cas/calendar/sem-mon/>), Energy colloquium (<http://www.skoltech.ru/en/energy-colloquium/schedule-for-the-winter-spring-2017/>), CDISE “Christmas colloquium on computer vision” (<http://sites.skoltech.ru/compvision/cccv17/>).

RECRUITMENT CAMPAIGN

The student recruitment campaign, performed by the Student Outreach and Recruitment office for the Academic Year 2017-2018 was initially designed in accordance with the best practices of foreign universities and represents an effort to be proactive and systematic in reaching out to prospective talented students in light of the fact that Skoltech lacks its own Bachelor’s program.

The main target of the student recruitment campaign for the 2017-2018 academic year was to attract, select and enroll talented and ambitious students (target numbers: 225 MSc and 95 PhD students).

The recruitment campaign included a variety of online and offline recruitment initiatives, as well as several stages of evaluation, which facilitated the selection of the most qualified candidates. It incorporated special software for processing applications – a unique approach in Russia, and one that corresponds with international student recruitment standards.

To promote Skoltech’s educational programs, the Student Outreach and Recruitment office established key recruitment initiatives, developed a set of marketing materials, designed and updated program pages on the Skoltech website and created a tailored landing page.

The key recruitment initiatives included target opportunities, recommended by faculty teaching at MIPT, MSU, HSE and other universities, conferences, competitions and contests in which Skoltech faculty were involved; events of various formats, including in-house outreach-events and events in target universities/cities in Russia and abroad. Overall, the Student Outreach and Recruitment office organized and/or participated in 43 events in 15 cities in Russia and abroad, with more than 4,500 participants and 27 Skoltech faculty involved.

In order to increase Skoltech’s visibility and the pool of prospective students, several content projects were launched jointly with media-partners, such as PostNauka (combined, published materials reached more than five million views), VC.RU (more than 600,000 views) and N+1 (more than 900 leads converted to potential candidates). In addition, different formats of Internet marketing (context and targeted ads), including SMM were actively used.

The brand-new CRM system for processing applications was developed and implemented in order to maintain the selection process with regard to its efficiency and submission ratio increase. The system provides integrated communication tools, such as a mobile interface, online chat and integration with Skoltech newsletters.

ENROLLMENT

During the recruitment campaign, Skoltech received 8,018 MSc applications and 2,993 PhD applications – five times higher than the results of the 2016-2017 campaign. The MSc admissions ratio for domestic students was 35:1. For foreign applicants, it was 100:1. The domestic PhD admission ratio was 31:1. For foreign applicants, it was 130:1; 71% of MSc and 87% of PhD applications were received from foreign candidates from 123 countries.

Of all submitted applications, 2,533 MSc applications and 1,109 PhD applications were properly filled and submitted – six times higher than the results of the previous campaign. Driven by the aim of selecting talented and motivated students, a two-stage selection process was applied:

1. Pre-selection: evaluation of a candidate’s portfolio (CV, recommendation letters, scientific and professional achievements, GPA)
2. Selection: on-site event, which included:
 - a. Interview with faculty panel
 - b. Written exam (Math part and a Specialization part) or online exam
 - c. TOEFL exam

As a result of the pre-selection, 646 MSc and 196 PhD candidates were invited and participated in selection events

>10,000 applicants from 123 countries for MSc and PhD programs in 2017

(including four MSc and two PhD selection waves). In 2017, travel expenses (tickets, accommodation) for the selection events were covered by participants themselves. Upon the results of the selection waves, 260 MSc and 123 PhD students received

offers to attend Skoltech. Of those, 250 MSc and 117 PhD students accepted offers and were enrolled in MSc and PhD programs. Six students were enrolled as “visiting.” Among the enrolled, more than 20% are foreigners from 35 countries.

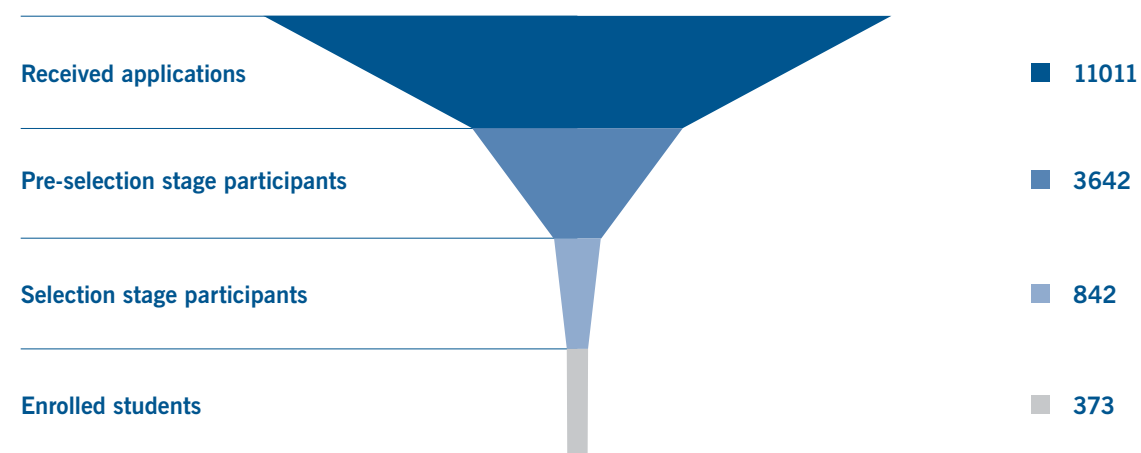


Figure 35. Recruitment funnel 2017

MSc admission ratio –
1:100
(foreign students),
1:35
(domestic students)

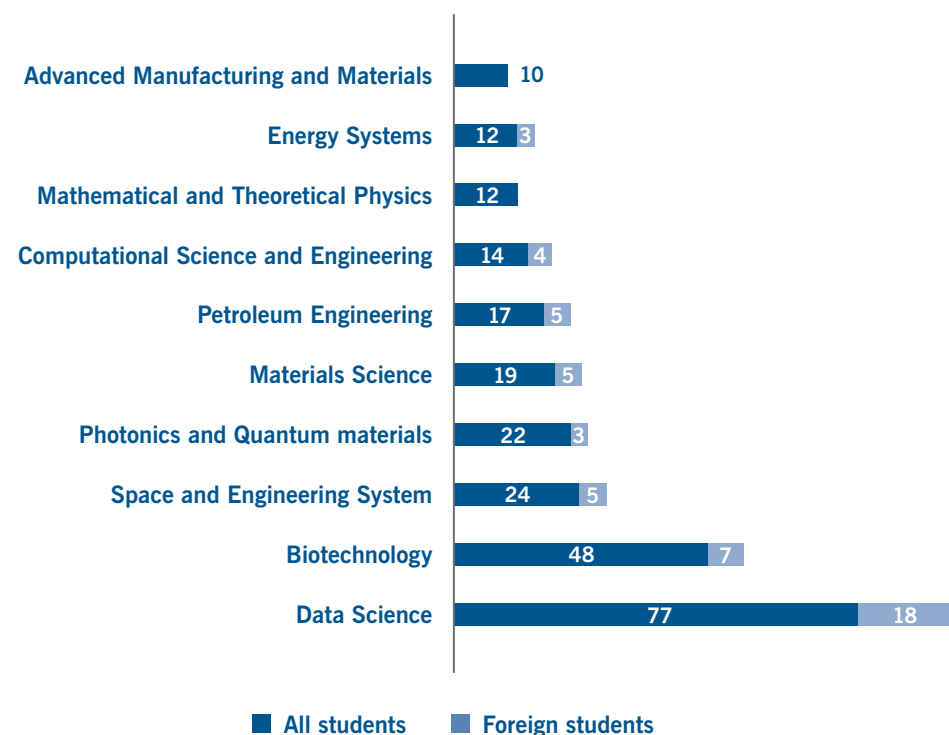
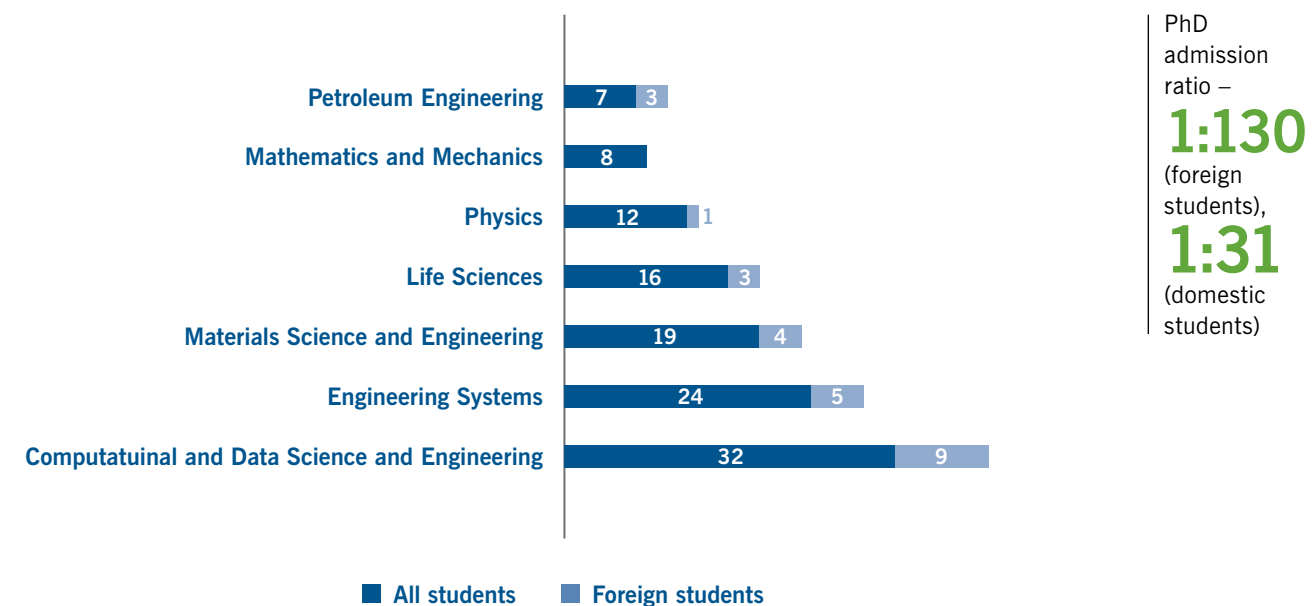


Figure 36. MSc student enrollment 2017 by program



PhD admission ratio –
1:130
(foreign students),
1:31
(domestic students)

Figure 37. PhD student enrollment by program

With regards to the academic background – 60% of the enrolled are graduates of top-10 Russian universities. More than 51% graduated from MIPT, MSU and HSE. Some 50% are graduates of the top 300 universities (QS, THE rankings). In

total, students of the 2017 intake represent 86 universities in 29 countries. Of these universities, 41 are located in 19 Russian cities from Grozny and Arkhangelsk to Vladivostok and Petropavlovsk-Kamchatsky.

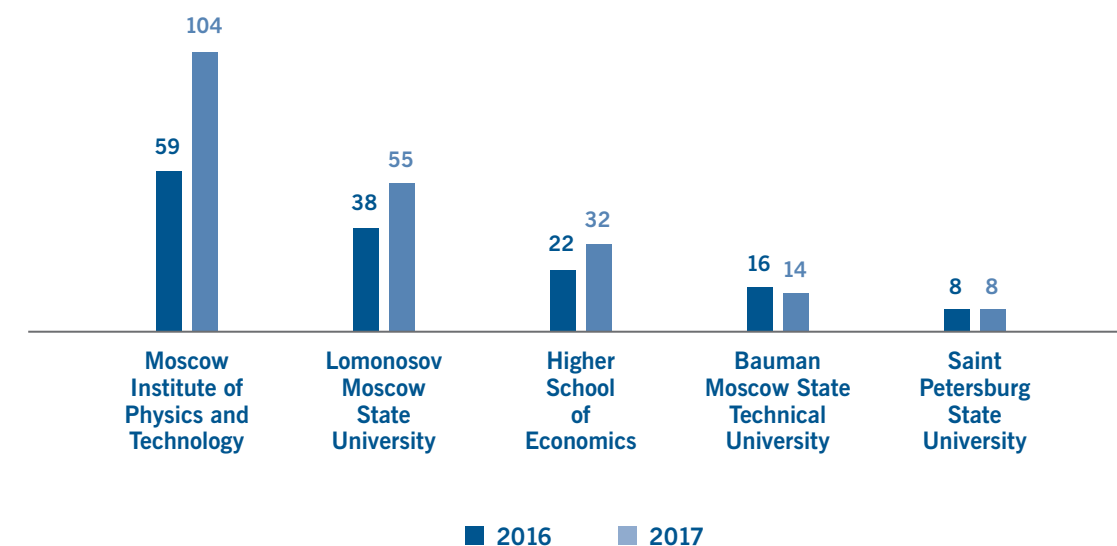


Figure 38. MSc and PhD students by previous university, broken down by the top five most common previous university.

JOINT PROGRAMS

As part of its academic development strategy, Skoltech launched several MSc Programs in partnership with Russian universities (“network” programs). The initiative was proposed with the goal of shaping a community of joint-university students by providing flexible opportunities, including specialized paths of study, research co-advising, one research thesis and one thesis defense.

The partner universities and fields of study were proposed by Skoltech faculty members taking into account ongoing research collaborations, program capacity building and students’ interest, evaluated based on previous recruitment campaigns. The preparatory activities included

negotiations with the academic leadership of the partner universities, defining admission requirements, programs structure and curriculum, the status of students in home and host universities and legal frameworks.

The curriculum of the partnership programs includes a Skoltech innovation component, primarily in the form of the Innovation workshop, as well as other courses aimed at increasing entrepreneurial skills (“Ideas to Impact: Foundations for Commercializing Technological Advances,” “Intellectual Property and Technological Innovation,” “Technology Entrepreneurship,” etc.). 6 MSc Programs in a network format were included in the recruitment campaign for AY 2017-2018.

Table 14. Network program

MSc PROGRAM	PARTNERS	NO OF STUDENTS FROM PARTNER UNIVERSITIES ENROLLED
Data Science	Higher School of Economics Moscow Institute of Physics and Technology State University of Aerospace Instrumentation	47
Mathematical and Theoretical Physics	Higher School of Economics Moscow Institute of Physics and Technology	11
Photonics and Quantum Materials	Moscow Institute of Physics and Technology Kazan Federal University	11
Computational Science and Engineering	Moscow Institute of Physics and Technology	5
Biotechnology	Far East Federal University Baltic Federal University Kazan Federal University	4
Petroleum Engineering	Kazan Federal University	1

FACULTY FEEDBACK

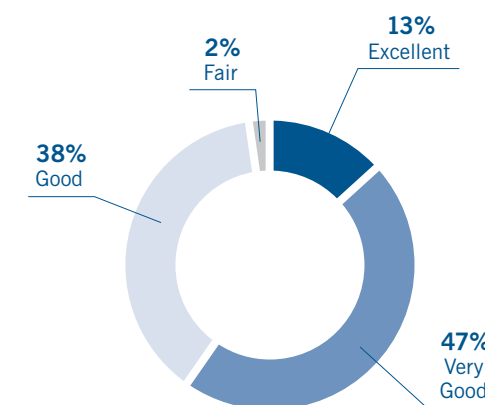
To identify the level academic performance of enrolled first year MSc students, a survey was performed among the Skoltech faculty and course instructors that delivered courses during Terms one and two of the Academic Year 2017-2018.

Of 67 professors surveyed, 45 answered all of the questions of the survey. According to the results, 60% of the responders estimated the academic performance of the first year MSc

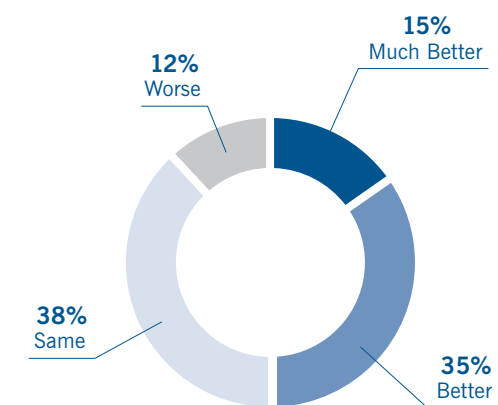
students as “Excellent” and “Very Good,” while 38% selected “Good.” None of the respondents estimated their students’ level as “Poor,” and only one person estimated the level as “Fair.”

Asked to compare the current intake with the 2016, intake, 50% of respondents characterized the level of this year’s students as “Much Better” or “Better,” 38% as “Same” and 12% (four persons) as “Worse.” No one characterized the level of the MSc intake of 2017 as “Much Worse.”

Q1: How would you generally score the performance level of first year MSc students in your courses?



Q2: Comparing the 1st year master students (MSc intake 2017) to the previous ones (MSc intake 2016), the overall level is:



MSc AND PhD STUDENT POPULATION

As of the end of the year, 427 MSc and 279 PhD students were studying at Skoltech. The distribution of students per target domain and CREI (based on research advisor affiliation) is presented in the figures below.

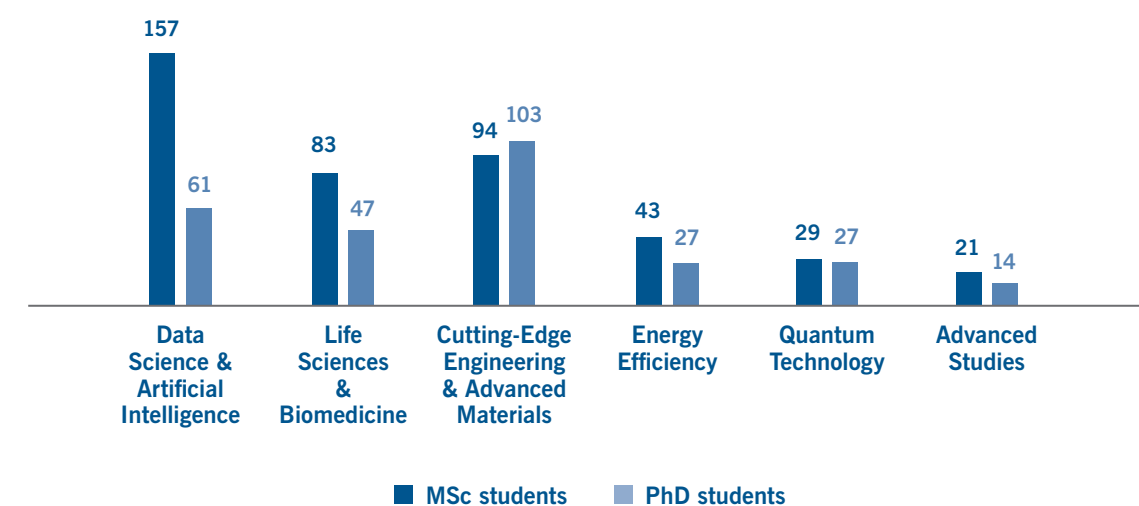


Figure 39. 2017 MSc and PhD students per target domain

60% of the enrolled are graduates of top-10 Russian universities, **50%** are graduates of the top 300 universities (QS, THE rankings)

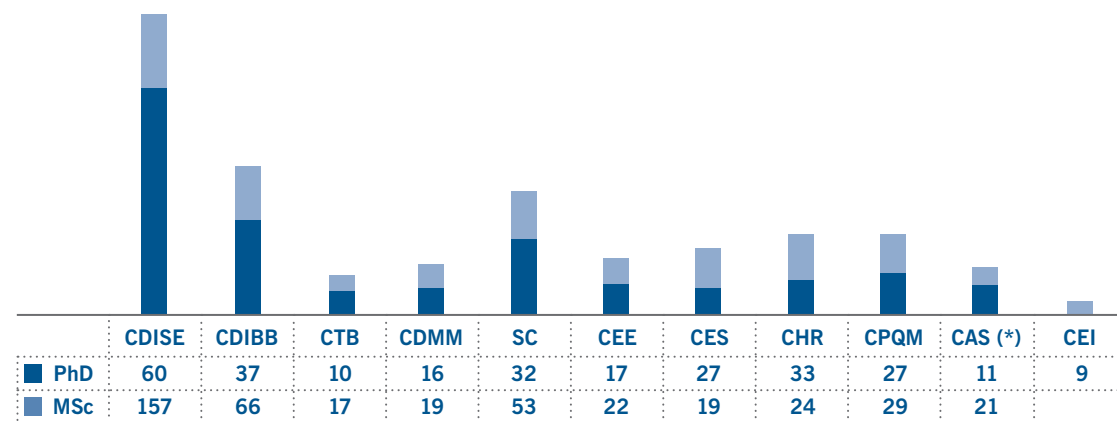


Figure 40. Distribution of MSc and PhD students by CREI (incl. CEI, as well as Mathematical and Theoretical Physics students (*))

The Skoltech Student Life Office (SLO, Office) provides a host of services aimed at improving the students' activities outside of regular studies. It also works to develop and maintain fruitful contacts with the Institute's growing network of alumni.

The main activities of the Office during 2017 are outlined below:

Keeping students in the loop: as part of Skoltech Communications team, the SLO informed students on events, opportunities and other issues that may be of interest or concern to them. In this sense, it facilitated all communications between Skoltech departments and the student body.

Easing the transition for international students: the Office has developed a new 'buddy' system to help international students prior to their arrival in Moscow. Using it, the SLO connects Skoltech students with incoming international students prior to the start of their first term. New students reported that it was very helpful to receive personalized guidance before coming to Skoltech. The SLO also helped international students with visa registrations and extensions.

Creating community: the SLO organized events aimed at helping students

develop lasting relationships outside of the classroom, including orientation day activities and parties after such academic-intensive programs as the Innovation Workshop. The Office was actively involved in organizing the ringing-the-bell and commencement ceremonies, as well as various student-related elements of Skolkovo Startup Village and Open Innovations Forum.

Liaising with the Student Council: in order to best meet the needs of the student body, the Office worked closely with their elected peers in Skoltech Student Council, responsible for social and extracurricular activities. In collaboration with the Student Council, the SLO has organized a range of fun activities, including movie nights, a Secret Santa gift exchange and a guided tour of the Moscow Metro. The Student Council is also responsible for representing student interests, as a result of which the Office helped them negotiate student housing opportunities in Skolkovo Tetris quarter. The SLO has also helped the Student Council establish 18 extracurricular clubs, ranging from the Aircraft Design Club to the Japanese Language Club, the Startup Club to the Basketball Club.



NINA MAZYAVKINA

The president of the Skoltech Student Council:

"Skoltech students are already a brand. They know exactly what they want to do are confident; they've got plans. They have solid critical thinking skills and they're always ready to get into a healthy debate. Another really important thing: people here aren't into showing off. They're really open and also just very interesting people."



Graduates and Alumni Network

The Skoltech Student Life Office strives to maintain contacts with all of the Institute's graduates as they enter the workforce in Russia and abroad. Toward this end, the Office held alumni gatherings at the Skolkovo Startup Village and Open Innovations Forum, where participants developed action plans for future activities and elected to create an alumni website.

The SLO has also begun work on a robust database tracking Skoltech

graduates' employment status and containing their current contact details. In particular, the SLO conducted an extensive survey of all Skoltech alumni (graduation of 2015, 2016, 2017) to find out their career paths. Most of the alumni – about 90% – responded to the questions about geographic distribution, income level, place of work, etc. The results of the survey are presented in the figures below.

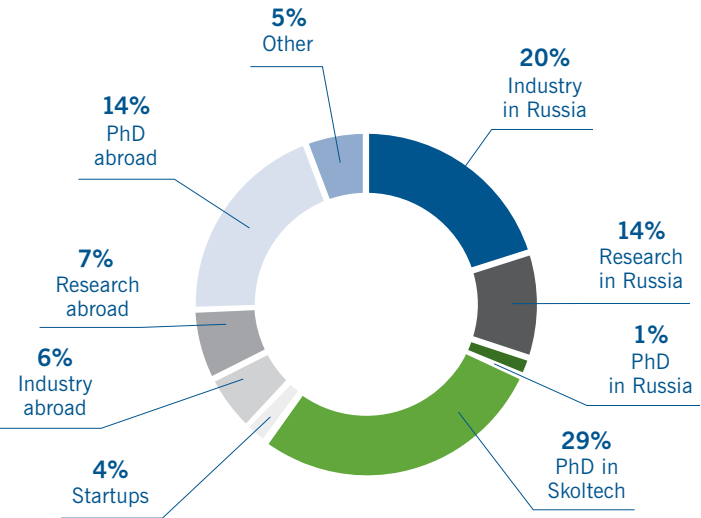


Figure 41. 2017 graduating class (% of respondents)

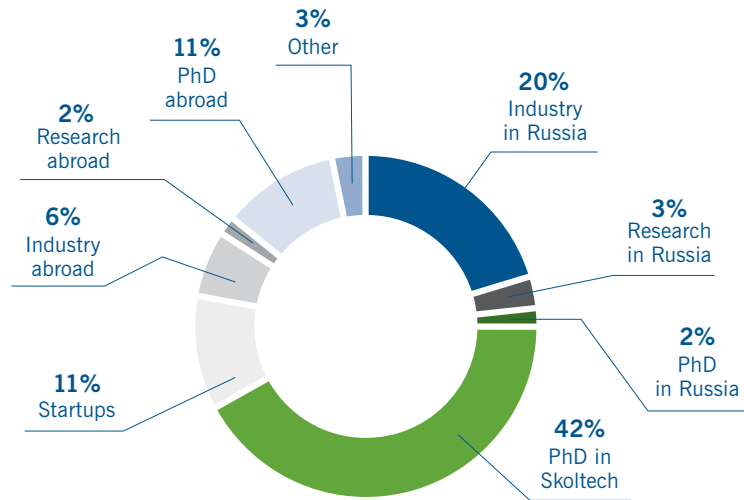


Figure 42. 2016 graduating class (% of respondents)

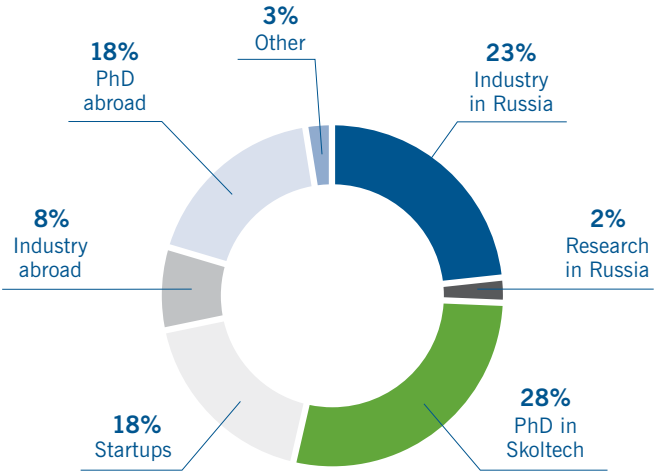


Figure 43. 2015 graduating class (% of respondents)

Details of the main categories are provided below:

Industry in Russia	Yandex, Cisco Inc., Runa Capital, Cognitive Technologies, T8, General Electric, Execution, NVIDIA, Alfa Bank, PROFI.RU, Habidatum, Virtuozzo, Sberbank, i2bf Global Ventures, Sputnik, Criteo Moscow, Megafon, Sbtech, Superjob.ru, Philips, Soft Company, Honeywell, TrueNorth, Elmetro
Research in Russia	Skoltech (research intern), Lomonosov Moscow State University, Burdenko Research Institute of Neurosurgery, Central Research Institute of Mechanical Engineering
PhD abroad	Max Plank Institute, University of Giessen, École Polytechnique Fédérale de Lausanne, University of California, Irvine, University of Cambridge, Swiss Federal Institute of Technology in Zurich, Stony Brook University, Carnegie Mellon University, University of Zurich, The German Aerospace Center, Technion, Rensselaer Polytechnic Institute, University of Amsterdam, Hasso Plattner Institute, Hong Kong University of Science and Technology, Hong Kong Polytechnic University, California Institute of Technology, GFZ German Research Centre for Geosciences
Industry abroad	Badoo, Airbus, Cisco Systems, Astro Digital, the Aerospace Committee of the Ministry of Defense and Aerospace Industry of the Republic of Kazakhstan, Aerostate, LeapMind, German Orbital Systems, Revolut Ltd., KPMG South Korea

Target Domains and CREIs

/05



CENTER FOR COMPUTATIONAL AND DATA-INTENSIVE SCIENCE AND ENGINEERING

Director	Prof. Maxim Fedorov
Research directions	Data Science and Artificial Intelligence Mathematical Modelling & Computational Engineering Distributed Intellectual Systems Advanced Computing Artificial Intelligence

Academic Excellence

Research highlights

Over 72 publications indexed in Web of Science/Scopus were published or in press in high impact factor journals in 2017, prestigious conferences and one book. Selected examples include:

- **Biamonte, J.**, Wittek, P., Pancotti, N., Rebentrost, P., Wiebe, N., & Lloyd, S. (2017). Quantum machine learning. Nature, 549(7671), 195-202. 10.1038/nature23474
- Li, Y., Wang, F., Chen, Y., **Cichocki, A.**, & Sejnowski, T. (2017). The Effects of Audiovisual Inputs on Solving the Cocktail Party Problem in the Human Brain: An fMRI Study. Cerebral Cortex, 1-15.
- **Somov, A.**, Karelin, A., Baranov, A., & Mironov, S. (2017). Estimation of a gas mixture explosion risk by measuring the oxidation heat within a catalytic sensor. IEEE Transactions on Industrial Electronics, 64(12), 9691-9698. 10.1109/TIE.2017.2716882
- Coles, S. W., Mishin, M., Perkin, S., **Fedorov, M. V.**, & Ivaništšev, V. B. (2017). The nanostructure of a lithium glyme solvate ionic liquid at electrified interfaces. Physical Chemistry Chemical Physics, 19(18), 11004-11010. 10.1039/c7cp00837f
- Kononenko, D., Ganin, Y., **Sungatullina, D.**, & **Lempitsky, V.** (2017). Photorealistic monocular gaze redirection using machine learning. IEEE Transactions on Pattern Analysis and Machine Intelligence, 10.1109/TPAMI.2017.2737423
- Saucedo, A., **Lefkimmatis, S.**, Rangwala, N., & Sung, K. (2017). Improved computational efficiency of locally low rank MRI reconstruction using iterative random patch adjustments. IEEE Transactions on Medical Imaging, 36(6), 1209-1220. 10.1109/TMI.2017.2659742
- **Cichocki, A.**, Phan, A. -, Zhao, Q., Lee, N., **Oseledets, I.**, Sugiyama, M., & Mandic, D. (2017). Tensor networks for dimensionality reduction and large-scale optimizations: Part 2 applications and future perspectives. Foundations and Trends in Machine Learning, 9(6), 431-673. 10.1561/22000000067
- **Oseledets, I. V.**, **Ovchinnikov, G. V.**, & **Katrutsa, A. M.** (2017). Fast, memory-efficient low-rank approximation of SimRank. Journal of Complex Networks, 5(1), 111-126. 10.1093/comnet/cnw008. In 2017 CDISE started participating the NTI project “4D Model of Tatarstan” as the part of a consortium with the total amount of income approximately 60 million rubles.

New NTI project proposals (one is for the NTI Centre for Artificial Intelligence) have been written.

In 2017 CDISE members won a couple of grants: 1 Ministry of Education and Science, led by Evgeny Burnaev (10 million rubles), one Mega Grant led by Andrzej Cichocki (90 million rubles), Russian Science Foundation: Ivan Oseledets (6 million rubles), Igor Ostanin (3 million rubles), and the Russian Foundation of Fundamental Research: five Grants (total 2.5 million rubles).

Education

During 2017 CDISE supervised 150 Master Students, 33 MSc were graduated. 60 PhD Students were supervised, two graduated. Two programs (Data Science, Computational Science and Engineering) were accredited. CREI members developed the number of courses in corporative education and successfully taught two courses for Sberbank employees (approx. 3 million rubles). The portfolio of such courses is growing rapidly.

Research infrastructure

The CREI established several laboratories in 2017.

The laboratory of 4D analysis established that its main goal is to conduct

research in accordance with an agreement between Skoltech and Innopolis to carry out an NTI project and to create within the CREI critical expertise in the area with prospects of commercializing the accumulated knowledge.

Two agricultural labs were established, one at Nobel St. 4, and another at a partner institute (Dokuchaev Soil Science Institute). These labs use unique equipment to analyze the physical properties of soil. A mobile laboratory (based in a KAMAZ) will be ready in February 2018.

CDISE established the Mega Grant tensor networks laboratory. This laboratory’s mission is to pursue cutting-edge research in the design and analysis of deep neural networks, tensor decompositions, tensor networks and multiway analyses with many potential practical applications. The Laboratory brings together several professors and young researchers in the fields of machine learning, computer vision, artificial intelligence, robotics, large-scale data analysis and mathematics, as well as computational neuroscience and bioinformatics.

A large amount of computational equipment has been purchased for installation in 2018 (around 1.5 Pflops of CPU/GPU computational power).

Value generation

CDISE concluded several industrial contracts in 2017 with Huawei (approx. 15 million rubles) in addition to ongoing projects and joint projects with CHR with Gazprom Neft (preliminary 30 million rubles) with CDISE co-PI and crucial

expertise. Several new contracts with Huawei are under consideration (the negotiation process has started). Four spin-offs are under development. Three patent applications have been submitted.



MAXIM FEDOROV
Director, CDISE:

“We educate visionaries – those able to predict the course science and industry will take in the next 10-20-50 years and make justified decisions.”

Cooperation & Serving the wider community

CDISE provides high-quality HPC service for the whole of Skoltech and has begun the process of creating the Center of Collective Usage for HPCs on the basis of the CREI and the Skolkovo Foundation's equipment. The CREI is deeply involved in the creation of a Russian supercomputer society. Toward the end, it has signed agreements with the Keldysh

Institute of Applied Mathematics and the National Research Center – Kurchatov Institute.

CDISE has two internal cross-central Biomedical Initiative Projects with CDIBB, which have become the engine of a relationship between Skoltech and the Scientific and Practical Psychoneurological Center named after Z.P. Solovyov.

Organization and participation in visible conferences, symposia, etc.

CDISE organized at Skoltech a workshop called Soilmatics, which attracted representatives from the most visible Russian soil science institutions (including the Dokuchaev Soil Science Institute, Lomonosov Moscow State University, Moscow Timiryazev Agricultural Academy) and agro-tech startups.

Traditionally at the end of December, CDISE organizes “Christmas Colloquium on Computer Vision”, where state-of-the-art work related to computer vision is presented. In addition to Skoltech, this year's participants included DeepMind, Intel, ENPC Paris, HSE and Facebook AI Research. The colloquium was sponsored by MES, Mapbox, and Yandex.

CDISE also actively participated in the organization of the Skoltech Gen-Y conference.

The CREI likewise contributed significantly to the organization of the Conference on Stochastic Processes and their Applications (www.spa2017.org), where Professor Evgeny Burnaev and research scientists Alexey Naumov delivered presentations.

Professor Dmitry Lakontsev organized a Russian university consortium called Modern Network Technologies.

CDISE also hosted an IoT hardware hackathon – an event hosted jointly by Skoltech and Rostelecom joint event.

CDISE faculty and researchers made at least 26 oral and 30 poster presentations at prestigious international conferences including rank A, A*(ICRA, CVPR, ICML, AAAI, ACL) in 2017.

In an effort to increase Skoltech international visibility of Skoltech, CDISE academic staff gave several invited talks during the year at such universities as the University of Exeter in the United Kingdom, and at RIKEN in Japan.

CDISE members were invited to speak at the International Forum of Technological Development Technoprom 2017, where Professor Dmitry Lakontsev served as chairman of the roundtable Industrial IoT, and Maxim Kuznetsov served as chairman of a roundtable on Artificial Intelligence.

Partners: RIKEN, Helmholtz Society, Huawei, Schlumberger, Philips, Astra Zeneca, MIT, Ohio State University, New York University, University of Strathclyde, University of Cambridge, Oerlikon, TU Munich, ChemRAR, RusAgro-Invest, Dokuchaev Soil Science Institute of RAS, MSU, Michurinsk State Agricultural Academia, National Research Centre Kurchatov Institute, Sberbank, Zyfra, Elvis, Gazprom Neft, RusAgro-Invest, Innopolis, Geoscan, VisonLabs, New Engineering Technologies, Minimax, MSU, ABBYY, Yandex, RosAtom, Lukoil.

Cyber Academy

In 2017, CDISE established the Cyber Academy, which it considers to be one of the most promising research and development initiatives in the scope of computer and mathematical science, which includes the development of complex AI (intellectual bot), data analysis, data featuring and data streaming.



CDISE has selected the Academy's research and educational focuses, as well as having chosen a service provider to create a game platform. At present, a professional team is being created and preliminary commercialization discussions are under way with various industry actors, such as Sberbank, Rostelecom, Akado and Visa. A more detailed plan is outlined in the SAP 2018-2020.

CoBrain

CDISE members have played leading role in developing the NTI project CoBrain, which has attracted external funding in the amount of ~300 million rubles. The research group developed several methods for classifying and categorizing of biomedical images and presented their findings at leading conferences (a conference on Medical Image Computing and Computer Assisted

Intervention (MICCAI) and the International Symposium on Biomedical Imaging (ISBI)).

CDISE launched several industry-oriented projects during the year. Notably, the P. Prikhodko group developed several algorithms for EEG analysis by request of Neurotrend, a leading Russian neuromarketing company, and Kazarian Epilepsy Center, a private medical company.

Partners: Atlas, Westrade, Neurotrend, PSY, Neurobotics, Smartmed, Genetico, Institute of Biomedical Chemistry, Innopraktika, PrimeBioMed, Eye Move, TestGen, Radiology Moscow, Intellogic, LLC Kazaryan Epileptology Centre, Shukina Psychologic Institute, International Center for personality investigation and development, Ippavlov, Genotek, Moscow Gerontology Scientific Centre, Unim, Fibrino, Knomix, Cliber Bioniks



ANDRZEJ CICHOCKI
Skoltech professor.

“We hope that after extensive coursework in ML and DL, our students will be equipped to develop a new generation of smart machines that will be useful for humanity, especially for a wide spectrum of biomedical applications.”



CENTER FOR DATA-INTENSIVE BIOMEDICINE
AND BIOTECHNOLOGY

Director	Prof. Konstantin Severinov
Research directions	Genomic editing Genomic-traits based selection OMICs analysis of brain function Antibiotics research



Academic Excellence

Multiple papers published provided under separate cover (CDIBB faculty and students names shown in bold). Highlight include papers in top journals like *Science*, *PNAS*, *Nature Chem. Biol.*, *Nature Biotechnol.*, and *JACS*.

Comprehensive transcriptome analysis of neocortical layers in humans, chimpanzees and macaques. He Z, Han

D, Efimova O, Guijarro P, Yu Q, Oleksiak A, Jiang S, Anokhin K, Velichkovsky B, Grünewald S, Khaitovich P. *Nat Neurosci.* 2017 Jun;20(6):886-895. doi: 10.1038/nn.4548. Epub 2017 Apr 17. PubMed PMID: 28414332.

Diversity and evolution of class 2 CRISPR-Cas systems. Shmakov S, Smargon A, Scott D, Cox D, Pyzocha N, Yan W,

Abudayyeh OO, Gootenberg JS, Makarova KS, Wolf YI, **Severinov K**, Zhang F, Koonin EV. *Nat Rev Microbiol.* 2017 Mar;15(3):169-182. doi: 10.1038/nrmicro.2016.184. Epub 2017 Jan 23. PubMed PMID: 28111461.

APOBEC3A/B-induced mutagenesis is responsible for 20% of heritable mutations in the TpCpW context. Seplyarskiy VB, Andrianova MA, **Bazykin G.A.** *Genome Res.* 2017 Feb;27(2):175-184. doi: 10.1101/gr.210336.116. Epub 2016 Dec 9. PubMed PMID: 27940951; PubMed Central PMCID: PMC5287224.

Klebsazolicin inhibits 70S ribosome by obstructing the peptide exit tunnel. Metelev M, Osterman I, **Ghilarov D**, Khabibullina N, Yakimov A, Shabalin K, **Utkina I**, Travin D, **Komarova E**, Serebryakova M, Artamonova T, Khodorkovskii M, Konevega A, **Sergiev P**, **Severinov K**, Polikanov Y. *Nat Chem Biol.* 2017 Aug 28. doi: 10.1038/nchembio.2462. [Epub ahead of print] PMID: 28846667

Analysis of Transcriptional Variability in a Large Human iPSC Library Reveals Genetic and Non-genetic Determinants of Heterogeneity Beckmann ND, D'Souza SL, Knowles JW, Patel A, **Papatsenko D**, Abbasi F, Reaven GM, Whalen S, Lee P, Shahbazi M, Henrion MY, Zhu K, Wang S, Roussos P, Schadt EE, Pandey G, Chang R, Quertermous T, Lemischka I. *Cell Stem Cell*, 2017 Apr 6;20(4):518-532.e9.

Multiplex gene editing by CRISPR-Cpf1 through autonomous processing of a single crRNA array. Zetsche B, Heidenreich M, Mohanraju P, **Fedorova I**, Kneppers J, DeGennaro E.M, Winblad N, Choudhury S.R, Abudayyeh O, Gootenberg J, Wu W, Scott D, **Severinov K**, Oost J, Zhang F. *Nature Biotechnology*, 35, 31-34 (2017) doi:10.1038/nbt.3737.

Human mismatch repair system balances mutation rates between strands by removing more mismatches from the lagging strand. Andrianova M, **Bazykin G**, Nikolaev S, Seplyarskiy V. *Genome Res.* 2017 May

16. doi: 10.1101/gr.219915.116. [Epub ahead of print] PMID:28512192

Antigen receptor repertoire profiling from RNA-seq data. Bolotin D, Poslavsky S, Davydov A, Frenkel F, Fanchi L, Zolotareva O, Hemmers S, Putintseva E, Obraztsova A, **Shugay M**, Ataullakhanov R, Rudensky A, Schumacher T, **Chudakov D.** *Nat Biotechnol.* 2017 Oct 11;35(10):908-911. doi: 10.1038/nbt.3979. PMID:29020005

The Product of Yersinia pseudotuberculosis mcc Operon Is a Peptide-Cytidine Antibiotic Activated Inside Producing Cells by the TldD/E Protease. Tsibulskaya D, Mokina O, Kulikovskiy A, Piskunova J, **Severinov K**, Serebryakova M, **Dubiley S.** *J Am Chem Soc.* 2017 Nov 15;139(45):16178-16187. doi: 10.1021/jacs.7b07118. Epub 2017 Oct 31. PMID:29045133

Education

Five graduate students defended their PhD degrees. They were among the first to do so at Skoltech.

The CREI also organized and held a bio-informatics and molecular biology summer school for undergraduates.

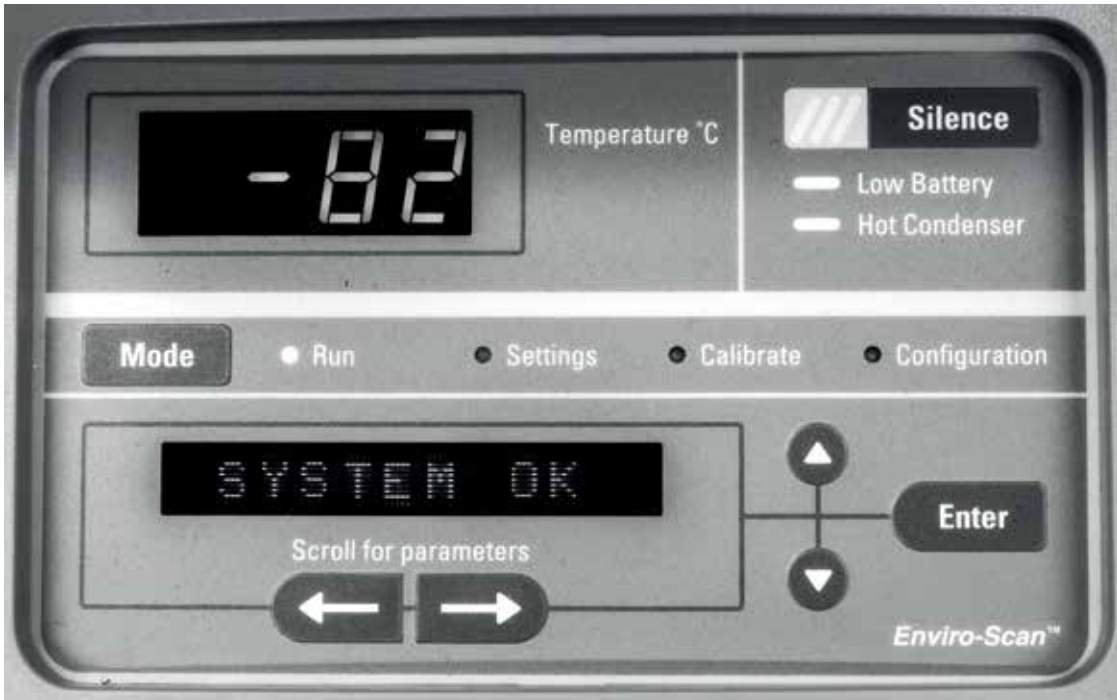
For the first time, MSc students from the Far Eastern Federal University and Kazan University were accepted as a part of joint programs with Skoltech.

A special stream of agricultural students were accepted from the Moscow Timiryazev Agricultural Academy.

CDIBB students conceived and performed laboratory projects with talented school children at the Sirius education center in Sochi in the summer of 2017.

Research infrastructure

A brand new teaching lab at the Technopark has been planned and equipped. The first students entered the lab at the end of 2017. The CREI has taken steps to organize the obtainment of high-level biological equipment into a communal use center for inside and outside users (the test case is the Skoltech Genomics center, which should be officially signed into being in February 2018).



Value generation

Main industry contracts, advisory services

Four new contracts with the Russian Ministry of Science and Education (with a total value of more than 125 mln rubles) were secured by CDIBB faculty and staff (Dr. Maria Logacheva,

prof. Philipp Khaitovich, prof. Konstantin Severinov).

On a regular basis, center faculty advise the Ministry of Science and Education, the Ministry of Agriculture, the Bortnik Foundation and the All-Russian Attestation Commission.

Cooperation & Serving the wider community

Projects with partners, partners' contributions

A project with Philip Morris International remains ongoing with respect to a Systems Biology fellowship; a new round of fellows were selected in 2017. The program is totally financed by Philip Morris International.

CDIBB worked on a project with the Polytechnic Museum related to an exhibition they hosted.

Open lectures etc.

CDIBB faculty members (prof. Mikhail Gelfand, prof. Konstantin Severinov, prof. Georgii Bazykin) made appearances via public lectures, radio and TV shows, news outlets, etc.



KONSTANTIN SEVERINOV
Director, CDIBB:

“Our PhD program in life sciences is new and very small – we have about 50 students and 15 professors only. Yet, according to Nature Publishing Group, Skoltech is ranked third in life sciences after such goliaths as the RAS and Lomonosov Moscow State University.”

CENTER FOR TRANSLATIONAL BIOMEDICINE

Director	Prof. Rupert Gerzer
Research directions	Validation of new targets for diagnostics and therapeutics in cancer Fibrosis and neuropsychiatric diseases Biomedical applications of mass-spectrometry

Academic Excellence

Research highlights

In 2017, CTB focused primarily on the validation of novel targets for diagnostics and therapy, and improved vehicles for targeted delivery of RNAs *in vivo*.

Thus, the two main achievements in 2017 were:

1) participation in a multi-team study of non-viral delivery of CRISPR-Cas9 system *in vivo* for efficient gene editing; in this study performed in collaboration with MIT (PI Prof. D. Anderson), we provided a crucial piece of the system: novel chemically modified enhanced sgRNAs;

2) participation in a multi-team study of the role of cholangiocytes in liver regeneration (in collaboration with Edinburgh University, PI Prof. S. Forbes).

Additionally, CTB participated in the solution of a structure of yeast telomerase TEN domain, specifying the mechanism of telomerase function and facilitating the design of anticancer drugs (joint lab with MSU, collaboration with EMBL).

CTB obtained significant achievements in studies of molecular pharmacology of mono-aminergic signaling in experimental animal models of brain pathology (in collaboration with Saint Petersburg State University).

CTB developed a number of novel approaches for high throughput identification of proteins, lipids, metabolites and

hormones in biological samples using the cutting-edge mass spectrometry facility in Skoltech.

Finally, a considerable amount of work on the development of a mass spectrometer based on Cassinian trap was performed that will result in a final prototype in 2018.

In 2017 CREI faculty and researchers published 62 papers in peer-reviewed journals (WoS and Scopus), among them, six were published in the Nature publishing group (Nature (in the 96th percentile), Nature Biotechnology (in the 99th percentile), Scientific Reports and one in Developmental Cell; also among them, about 25 papers belong to Q1 WoS.

Prof. Olga Dontsova became a member of the Russian President Council on Science and Education and a member of the President Scientific Hiring Committee. She is a full member of the Russian Academy of Sciences (Head of Physico-Chemical Branch), head of the expert group for Biology in the Russian Science Foundation, a member of High Council and Bureau in the Russian Foundation for Basic Research, an editor at Biochimie, and a member of the editorial board at Acta Naturae.

Prof. Evgeny Nikolaev (in 2017 professor of SC, from 2018 of CTB) is a corresponding member of the Russian Academy of and a member of the editorial boards of Rapid Communications in Mass Spectrometry, the European Journal of Mass Spectrometry and Mass Spectrometry Reviews.

In 2017, Nikolaev received the prestigious European grant Horizon-2020 to provide the EU academic and industrial communities with access to world-class ultra-high-resolution mass spectrometry centers and to foster a European community of mass spectrometry researchers and practitioners.

Dr. Olga Sergeeva received a grant for researchers from Russian Science Foundation. CTB currently has two projects supported by NGP grants and one by the SBI programs.

Education

In 2017, four new courses (“RNA biology,” “Instrumental methods in molecular biology,” “Earth observation systems and measurements” and “Advanced practical course on modern methods in molecular/

cellular biology”) were developed by CTB faculty members.

Currently, the CREI has eight PhD students and 12 MSc students supervised. Only three MSc students from the CREI graduated in 2017, but most of active CTB faculty members were hired in 2016.

Research infrastructure

In 2017 the CTB labs at Skoltech, as well as joint labs, were significantly enhanced with new equipment and enhanced with new post-docs. Thus, the CREI can now perform the full pipeline of modern biomedical research – from molecular biology approaches to animal studies empowered by mass spectrometry analyses. The CREI purchased a cutting-edge TiMS-TOF mass spectrometer in 2017, which it anticipates will strongly impact its current studies.

Value generation

An agreement for contract research with Generium was prepared (NDA signed and contract prepared, to be signed in early 2018).

Yuri Kotelevtsev is a member of Scientific Advisory Board at the Boston Gene company and also became a member of Marlin-Biotech (Skolkovo resident).

A project aimed at developing a system for the remote detection of explosives

was carried out in the cooperation with Lavana-U LTD.

Two patent applications were prepared (Cassini trap and peptide fragmentation methods).

Dr. Tatiana Prikazchikova participated in the Startup Village, presenting an automatic dose station, in collaboration with the CPQM CREI.

Cooperation & serving the wider community

Projects with partners, partners' contributions

CTB has joint projects with MIT (MRA and NGP supported – training of MSc and PhD students, access to top-level facilities, mentoring), Lomonosov Moscow State University (MRA supported – joint lab, training of MSc and PhD students, access to high-level facilities, mentoring), the Institute of Developmental Biology (joint lab, animal studies in vivarium, transfer of prolonged hepatocellular carcinoma mice model to

Skoltech), the Institute of Medical and Biological Problems (joint OMICS studies on the influence of space on health, optimization of mass spectrometry methods), Erlangen-Nurnberg University (modified nucleic acids for cancer-specific action in vivo, organic synthesis of precursors), the Institute of Physical Organic Chemistry (modified nucleic acids for improved targeted delivery, organic synthesis of the cell surface ligands), and the Scottish Center for Regenerative Medicine

of the University of Edinburgh (studies on liver regeneration, access to cutting edge transgenic animal models).

Prof. Yuri Kotelevtsev organized several industry-oriented seminars:

1) For the Russian branch of the Sanofi company on “Novel therapeutics based on RNA interference. From lab studies to clinical trials;”

2) For the Russian branch of the Janssen company (together with Dr. Vera Rybko) on “Novel drugs and platforms for oncological, systemic and hereditary diseases.”

Timofei Zatsepin presented a seminar for the Generium company on “RNA interference as a tool for target validation in vivo.”

CTB reviewed upwards of 29 projects for the Skolkovo Foundation in 2017.

Organization and participation in visible conferences, symposia, etc.

CTB organized a seminar at Skoltech for biotech companies on “RNA interference in vivo: on “Magnetic nanoparticles and carbon nanotubes as enhancers for targeted RNA delivery in vivo” (jointly with the CPQM).

MSc student Renata Ialchina was a member of the student organizing committee for the conference “Shaping the Future: Big Data, Biomedicine and Frontier Technologies,” which Skoltech cohosted with MIT.

Dr. Olga Sergeeva was a member of the organizing committee and Associate Professor Timofei Zatsepin was a member of the

program committee for the Skoltech Gen-Y conference.

CTB members made at least 15 oral presentations and 20 poster presentations at prestigious international conferences, such as the 65th Conference on Mass Spectrometry and Allied Topics, in 2017.

Prof. Yuri Kotelevtsev gave a talk at the student conference Biology-Science of XXI century on the “Search and validation of pharmacological targets by transgenic models in vivo,” which increased Skoltech’s visibility among students and attracted a number of candidates for MSc and PhD studies at Skoltech.



RUPERT GERZER

Deputy Chairman, Provost, Skoltech:

“The City of Moscow is currently in the process of establishing the Moscow International Medical Cluster, as well as a new Biotech Park at the Skolkovo Innovation Center. Skoltech strongly supports these initiatives and is prepared to spearhead close collaborations with the new international healthcare providers in all respective fields.”

Cutting-edge Engineering & Advanced Materials



CENTER FOR DESIGN, MANUFACTURING AND MATERIALS

Director	Prof. Iskander Akhatov
Research directions	Advanced and Digital Technologies

Academic Excellence

CDMM conducts basic and applied research aimed at development and implementation of new simulation-driven design and manufacturing paradigms for advanced materials, structures, and engineering systems with enhanced lifecycles, mechanical and physical characteristics demanded in high-tech industries. At the moment, the CDMM CREI consists of four main research and educational thrusts: (1) composite materials and structures (PCM), (2) additive manufacturing (3D Printing), (3) information technologies for advanced manufacturing (PLM), and (4) micro- and nanomechanics of advanced manufacturing.

Research highlights

Over 30 publications indexed in the Web of Science were published or in press in high impact factor journals in 2017, as well as more than 20 publications in conference proceedings. Selected examples include:

- **S.G. Abaimov**, Non-equilibrium annealed damage phenomena: A path integral approach, *Front. in Phys.*, **5** (6), pp. 1-16, 2017.
- V. I. Betekhtin, A. G. Kadomtsev, M. V. Narykova, M. V. Bannikov, **S. G. Abaimov, I. Sh. Akhatov**, T. Palin-Luc, O. B. Naimark, Experimental and theoretical study of multiscale damage-failure transition in very high cycle fatigue, *Phys. Mesomech.*, 20(1), pp 78–89, 2017.

- Brown-Dymkoski, E. and **Vasilyev, O.V.**, Adaptive-Anisotropic Wavelet Collocation Method on General Curvilinear Coordinate Systems, *Journal of Computational Physics*, 333, pp. 414-426, 2017.
- Dubinskii S.V., **Safonov A.A.** Composite-Friendly Approach to Certification of Advanced Materials and Fabrication Methods used in Aviation Industry. *Journal of Machinery Manufacture and Reliability*, 46 (5), pp. 501-506, 2017.
- B.N. Fedulov, **A.A. Safonov**, M.M. Kantor, S.V. Lomov Modelling of thermoplastic polymer failure in fiber reinforced composites, *Composite Structures*, 163 (1), pp. 293–301, 2017.
- Nail A. Gumerov, **Iskander S. Akhatov** Modes of self-organization of diluted bubbly liquids in acoustic fields: One-dimensional theory, *The Journal of the Acoustical Society of America* 141, 1190, 2017.
- Trofimov, A., **Abaimov, S.**, **Akhatov, I.**, and Sevostianov, I. Effect of elastic contrast on the contribution of helical fibers into overall stiffness of a composites. *International Journal of Engineering Science* 120, pp. 31-50, 2017.
- I. Shakhova, E. Mironov, **F. Azarmi, A. Safonov**, Thermo-electrical Properties of the Alumina Coatings Deposited by Different Thermal Spraying Technologies, *Ceramics International*, 43 (2017) pp. 15392-1540.

Education

Over 11 courses are available within the licensed and accredited MSc program in Advanced and Digital Engineering Technologies and the PhD program in Mechanics. As of the end of 2017, 19 MSc and 10 PhD students were enrolled in these programs.

Courses: Industrial Robotics; Mechanics and Physics of Advanced Manufacturing; Additive Manufacturing; Composite Materials and Structures; Introduction to Product Lifecycle Management (PLM); Advanced PLM Techniques I: Digital Design and Optimization; Advanced PLM Techniques, II: Digital Manufacturing and Model Validation; Continuum Mechanics; Structural Analysis and Design; Micromechanics; Fracture Mechanics; Numerical Methods in Engineering and Science.

Research infrastructure

The *Composite Materials and Structures Laboratory* focuses on the development novel composite material; research and certification testing of material components, materials, structures and structural elements; accelerated certification of materials and structures; design models of technological processes for the manufacturing of structural elements from composite materials, providing a transition to “digital” production with the optimization of its parameters.

Value generation

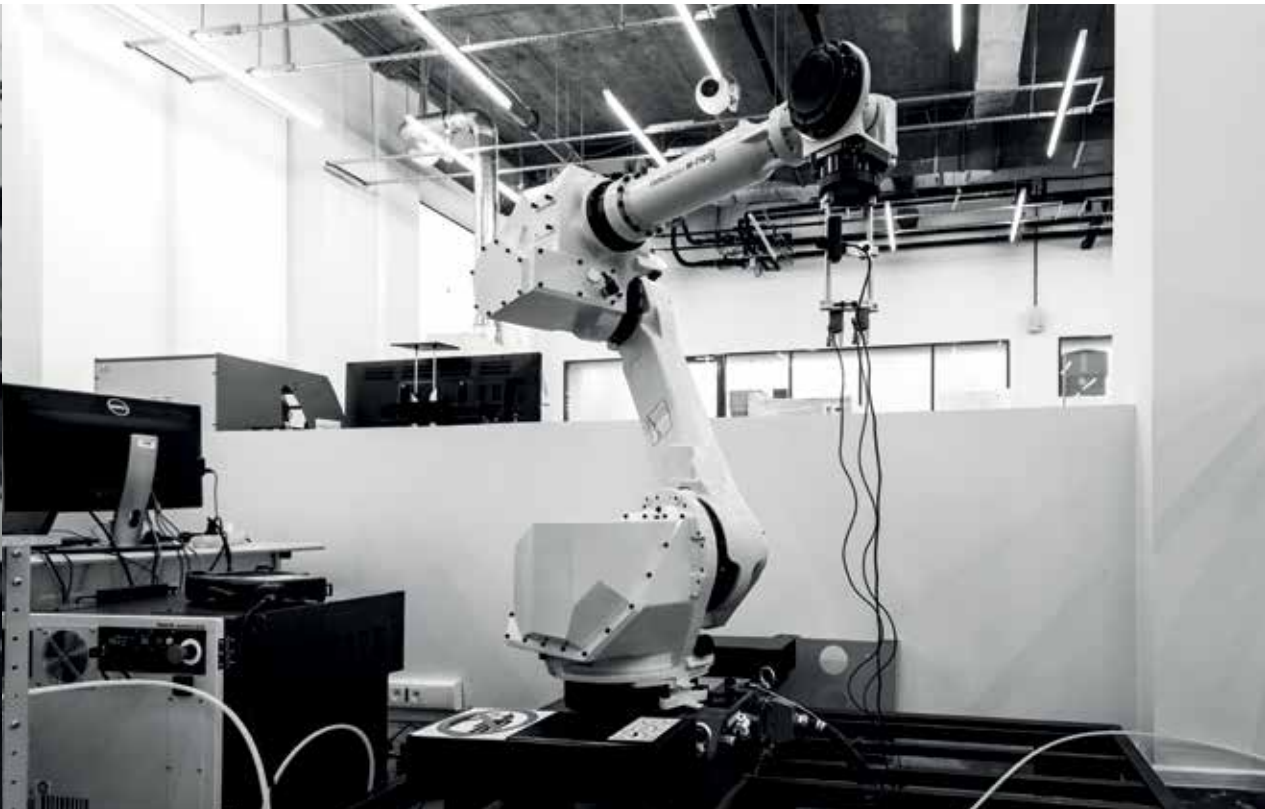
The development of the project “Experimental-Digital Certification Platform for Advanced Manufacturing Materials and Products” is *to be supported* by the NTI (about 150 million rubles for three years). The development of the project *to be included* to the “Center of Excellence on Advanced Manufacturing” of the National Technology Initiative (*about* 120 million rubles for three years). CDMM initiated collaboration with the Technical University of Munich and signed a Collaborative Agreement.

The *Advanced Manufacturing Laboratory* consists of three main research facilities: additive manufacturing, industrial robotics, and thermal spraying. The facilities include various high-tech 3D printing equipment capable of the production of a variety of components and tools from metals, ceramics, polymers, and composites, advanced robots and robotic systems with programing capabilities. The thermal spraying facility is planned to be operational in fall 2018.

The *Information Technologies for Advanced Manufacturing Laboratory* has been put into operation. Research areas include: product lifecycle management methods and tools, simulation-driven product development methodology, experimental methods for structural models’ validation.

The *Micro- and Nano-Mechanics Laboratory* consists of mechanical characterization and mechanical testing facilities. The key areas of research include: the design and optimization of new materials and the development of new approaches for non-destructive testing and structural health monitoring. The range of studied materials includes polymer fiber-reinforced composites, materials with nano-reinforcement, ceramics, 3D materials, coatings and especially thermal barrier coatings.

CDMM launched a joint lab for Additive Manufacturing with Oerlikon. Oerlikon covers rental space costs and equipment costs, and support three specific projects (about 15 million rubles per year). The CREI has an ongoing industry project with JSC Academician M.F. Reshetnev Information Satellite Systems for the development of technology for the industrial production of the lightweight perforated honeycomb core of aluminum foil structures for spacecraft.



Cooperation & Serving wider community

Prof. Iskander Akhatov

- Member of the National Committee for Theoretical and Applied Mechanics of Russia
- Medal of Kh.A. Rakhmatulin awarded by the National Committee for Theoretical and Applied Mechanics of Russia
- Journal of Nonlinear Engineering (Editorial Board member)
- Chair of the FANO Committee on Evaluation of RAS Institutes in the field of Mechanics

Prof. Sergey Abaimov

- Associate Editor, Frontiers in Interdisciplinary Physics

Prof. Robert Nigmatulin

- Member of Russian Academy of Sciences
- Member of Presidium of Russian Academy of Sciences
- Member of the Academy of Sciences of Republic Bashkortostan, Russia

Prof. Oleg Vasilyev

- Associate Editor, Theoretical and Computational Fluid Dynamics, Springer

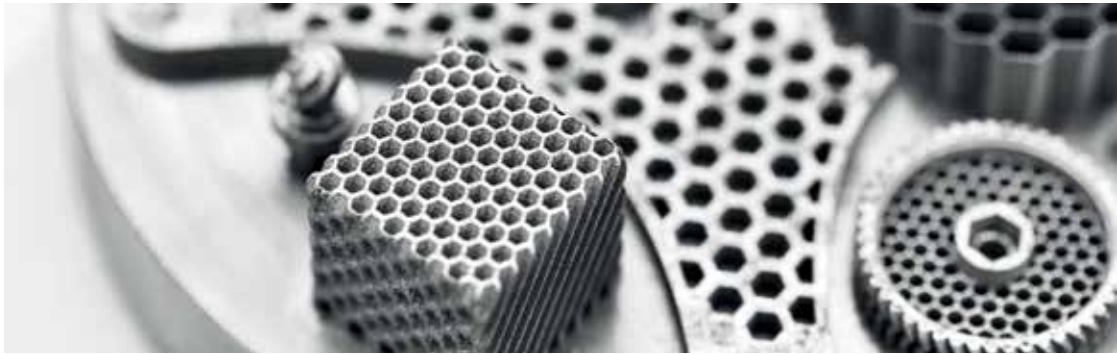
Organization and participation in visible conferences, symposia, etc.

CDMM faculty are highly visible participants in international conferences. Selected examples include:

Prof. Iskander Akhatov: Physics and Mechanics of Advanced Manufacturing (Invited lecture in Barcelona Tech University); Additive Manufacturing Symposium in Munich (Invited Panel)

Oleg Vasilyev, “Hierarchal wave-let-based modeling of turbulent flows,”

The 32nd Turbulence Simulation and Flow Design (TSFD) Symposium, Institute of Industrial Science, The University of Tokyo, Japan, March 22, 2017 (Invited talk), “Hierarchical wave-let-based modeling of turbulent flows,” The Sixth International Conference Tenth Anniversary Program ‘Turbulent Mixing and Beyond’, Trieste, Italy, August 14-18, 2017.



ISKANDER AKHATOV
Director, CDMM:

“We can design an entire engine and test it virtually. This approach drastically reduces the time spent on manufacturing new objects.”

SPACE CENTER

Director	Prof. Anton Ivanov
Research directions	Novel lifecycle and systems engineering techniques Integrated systems leading to product development with focus on systems of systems approach (space, aero and surface segment)

Academic Excellence

In 2017, the Space CREI underwent significant changes. Interim Director Alessandro Golkar assumed a leadership position at Airbus Defense and Space (on leave from Skoltech). The Space Center is now led by Prof. Anton Ivanov.

The Space CREI’s research supports space exploration efforts, with the aim of addressing current societal challenges and changing nature of today’s complex systems.

Two main research focuses include advanced engineering (including space and systems engineering technologies, robotics and product life cycle methodologies) and remote sensing (the development of commercial services based on system-of-systems research).

Research highlights

- **Matevosyan, H., Lluch, I., Poghosyan, A., Golkar, A.,** “A Value-Chain Analysis for the Copernicus Earth Observation Infrastructure Evolution: A Knowledgebase of Users, Needs, Services, and Products,” IEEE Geoscience and Remote Sensing Magazine, Vol. 5, Issue 3, 2017, doi: 10.1109/MGRS.2017.2720263.
- **Knoll, D., Golkar, A.,** “A coordination method for concurrent design and a collaboration tool for parametric system models,” Concurrent Engineering: Research and Applications, 2017, doi:10.1177/1063293X17732374.
- **Golkar, A., Selva, D., de Weck, O.L.,** “Introduction to the Special Issue on

Federated and Fractionated Satellite Systems,” Journal of Aerospace Information Systems, Vol. 14, No. 8 (2017), pp. 411-411, doi: 10.2514/1.1010545.

- **Podladchikova T.,** R. Van der Linden, and A.M. Veronig (2017). Sunspot number second differences as precursor of the following 11-year sunspot cycle. The Astrophysical Journal, 850, 81, doi:10.3847/1538-4357/aa93ef
- **Podladchikova T.V.,** and A.A. Petrukovich (2017), Forecast of future geomagnetic storm strength: five years online, European Geosciences Union General Assembly 2017 (April 23 - 28, Vienna, Austria).
- **Kostyukevich, Y.,** Shulga, A.A., Kononikhin, A., Popov, I., **Nikolaev, E.,** Deyev, S., CID fragmentation, H/D exchange and supermetallization of Barnase-Barstar complex, (2017) Scientific Reports, 7 (1), art. no. 6176, DOI: 10.1038/s41598-017-06507-2
- Larina, I.M., Percy, A.J., Yang, J., Borchers, C.H., Nosovsky, A.M., Grigoriev, A.I., **Nikolaev, E.N.,** Protein expression changes caused by spaceflight as measured for 18 Russian cosmonauts, (2017) Scientific Reports, 7 (1), art. no. 8142, DOI: 10.1038/s41598-017-08432-w
- **Kostyukevich, Y.I.,** Kononikhin, A.S., Indeykina, M.I., Popov, I.A., Bocharov, K.V., Spassky, A.I., Kozin, S.A., Makarov, A.A., **Nikolaev, E.N.,** Secondary structure of A (1–16) complexes with zinc: A study in the gas phase using deuterium/hydrogen exchange and ultra-high-



resolution mass spectrometry, (2017) Molecular Biology, 51 (4), pp. 627-632., DOI: 10.1134/S0026893317030104

- Thomas, N., Cremonese, G., Ziethe, **Ivanov A.B.** et al , The Colour and Stereo Surface Imaging System (CaSSIS) for the ExoMars Trace Gas Orbiter, (2017) Space Science Reviews, 212 (3-4), pp. 1897-1944. Cited 1 time. DOI: 10.1007/s11214-017-0421-1

Grants

- Significant grant with Airbus Defense and Space in negotiation for 2018.

Awards

- WareVision received a special prize from Gazprom Neft (150 kRub)
- Eurobot Russia Champions. Skoltech's reSET team, Russia. 5th place in the World Eurobot Championship, 24-28 May 2017, la Roche-sur-Yon, France.

Education

Seven courses were delivered for the Space and Engineering Systems Curriculum in 2017: Robotics, Dynamic Systems and Control, Space Systems Engineering, Spacecraft Mission Analysis and Design, Introduction to Remote Sensing, Space Sector Course, and Experimental Data Processing.

The Space CREI graduated Skoltech first PhD student, as well as 16 MSc students in 2017. During the course of the year, it recruited 25 students, bringing the total number enrolled in the program to 46.

Research infrastructure

Space Technologies Lab (Prof. Anton Ivanov) to concentrate on development of miniaturized technologies for navigation, remote sensing and communication applications. New testing facilities will be implemented in 2018.

Value generation

- Apple tree disease detection using a drone with computer vision. Soyu-zSnab-Skoltech Joint grant. Amount: 3.0 million RUB;
- Skoltech provided a Systems Engineering course to the MAI Management School (Prof. Anton Ivanov), 1 full week, 70 participants (United Aviation Corporation, United Motor Corporation, Untied Shipbuilding Corporation);
- Skoltech participated in advising on road map development for Roscosmos;
- The Space Center and CDISE participated in a 4D mapping project for the Republic of Tatarstan (funded by NTI). Development of an application for monitoring of oil and gas infrastructure;
- New startups are being formed: Lexy Smart, Webot telepresence, Tsuru Robotics, Tardis.AI, CardioLog.

Cooperation & Serving the wider community

Prof. Alessandro Golkar

- Member of the Editorial Board of the journal Concurrent Engineering Research and Applications
- Member of the Editorial Board of INCOSE Systems Engineering journal

Prof. Tatiana Podladchikova

- Managing Editor: REACH – Reviews in Human Space Explorations, Elsevier
- Member of International Space Weather Medals Committee

Prof. Evgeny Nikolaev

- Rapid Communications in Mass Spectrometry, Impact Factor: 2.226
- Spectrometry Reviews, Impact Factor: 9.373
- Corresponding member of Russian Academy of Sciences

Prof. Anton Ivanov

- Co-Chair, Small Satellites section, Reshetnev Readings, Krasnoyarsk
- Engineering Tutor, ESA Alpbach summer school
- Member of the Horizon 2020 Space experts panel (Brussels)

Projects with partners, partners' contributions

Open lectures etc.

- “How the Sun changes the Earth: climate turns,” Kultura TV, show “Nablyudatel,”
- “Sun and Space Weather,”

Experimentarium Science Museum, educational program “Scientists for kids,” Moscow (March 11, 2017).

- “In arms of the star called the Sun,” The Spring School for the Oxford Russia Fund fellows.

Organization and participation in visible conferences, symposia, etc.

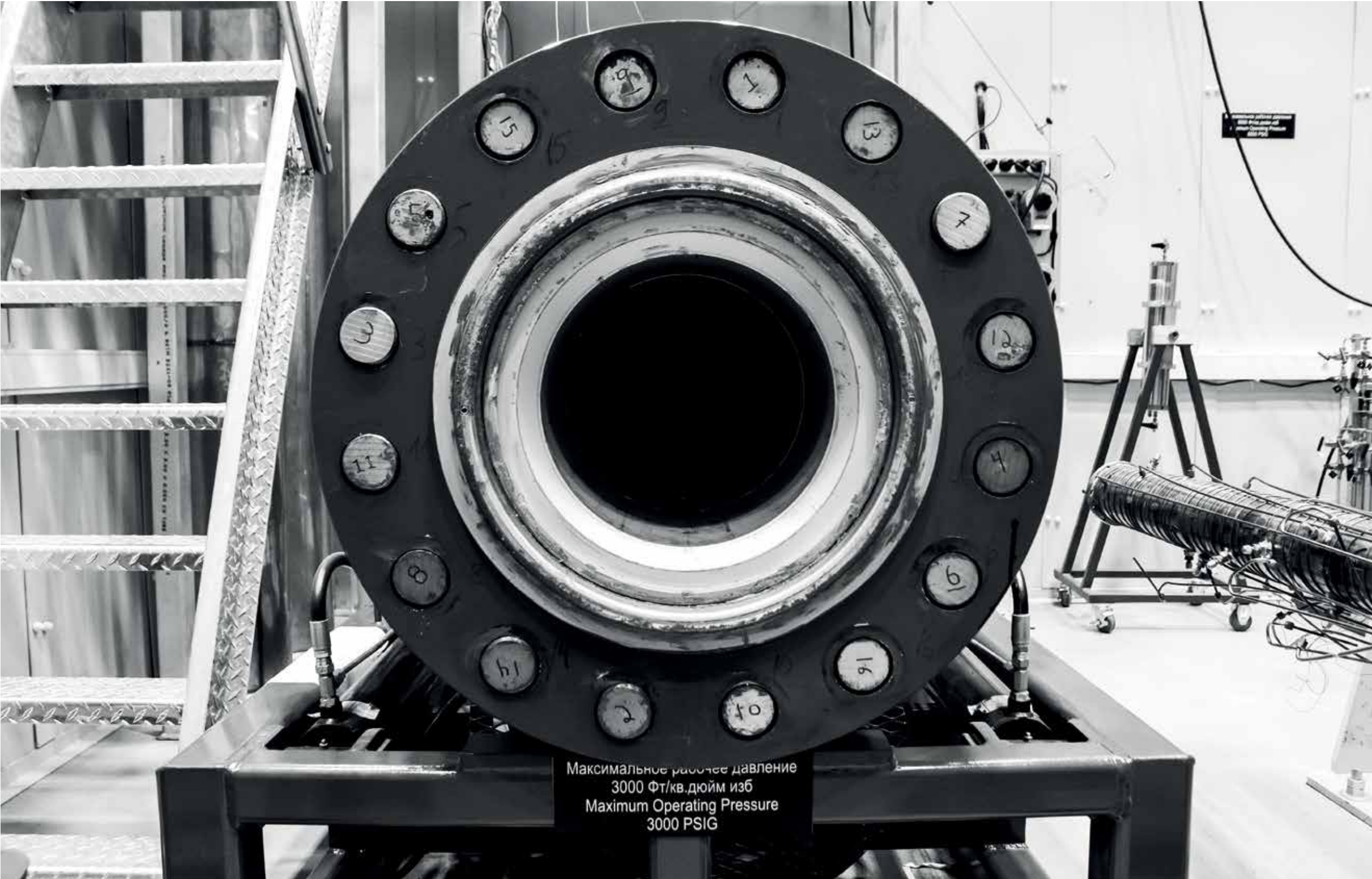
The Space CREI faculty were highly active in organizing conferences and workshop. Among many others were the first Friends of the Skolkovo Space Cluster conference involving Skoltech, Skolkovo Industrial

Cluster and Roscomos and its subsidiaries companies (Prof. Anton Ivanov. Dr. Andrey Potapov), as well as active organizers of the Federated Satellite Systems Workshop (Prof. Alessandro Golkar)



ANTON IVANOV
Director, SC:

“We want students to leave Skoltech with an understanding of their abilities, with an understanding of how much time the development of a complex engineering system takes. So that they use this systematic approach to build airplanes, helicopters and ships, namely, for work with any other complex system.”



CENTER FOR HYDROCARBON RECOVERY

Director	Prof. Mikhail Spasennykh
Research directions	<p>Petroleum science and engineering disciplines, including:</p> <ol style="list-style-type: none">1. Geomechanics;2. Enhanced oil recovery;3. Exploration and production of unconventional hydrocarbons;4. Gas hydrate and permafrost;5. Geophysics;6. Multiphase flow modeling;7. Data science in oil and gas industry; <p>In application to hard-to-recover and unconventional hydrocarbon resources including brown fields, tight oil reservoirs, heavy oil fields, oil shales, gas hydrate bearing formations and oilfields on the Arctic shelf and in the Polar regions.</p>

Academic Excellence

Key R&D directions in the area of petroleum science and engineering disciplines include enhanced oil recovery, exploration and the production of unconventional hydrocarbons, geomechanics, gas hydrate and permafrost, geophysics, multiphase flow modeling, data science in application to hard-to-recover and unconventional hydrocarbon resources including brown fields, tight oil reservoirs, heavy oil fields, oil shales, gas hydrate bearing formations and oilfields on the Arctic shelf and in the Polar regions.

In 2017, the SCHR executed more than 50 research projects including 12 research projects jointly with university partners, 32 research contracts with industry and three contracts in the context of grant supported by the Russian Science Foundation and the federal Ministry of Science and Education.

The results of their research have included the development of technologies, research reports, scientific publications, presentations on international conferences, and so on.

Research highlights

- Breakthrough experimental results and detailed characterization of petrophysics, geochemistry, and geomechanics of the Bazhenov formation (the largest oil shale

formation in the world), the Domanic formation (second largest shale formation in Russia) and the Beresov formation (recently discovered tight gas formation);

- New approaches, mathematical models, numerical algorithms and simulators for unconventional reservoir process modeling, including fracture branching in shale formations, proppant transport in fractures and wells, hydrofracturing monitoring, full waveform inversion for the interpretation of geophysical data, new approaches for hydrodynamic modeling of complex reservoirs, etc.;
- Breakthrough technological solutions for the production of unconventional (oil shale) and hard-to-recover reserves (heavy oil and carbonate reservoirs) using thermal methods of enhanced oil recovery;
- The successful start of a new research area: machine learning applications and big data analysis in the oil and gas industry;
- Winter field work at the Yamal peninsula focused on the study of Yamal gas craters, organized jointly with Total Oil Company and the Government of the Yamal Nenets Autonomous Okrug;
- Assistant Professor Andrey Osiptsov defended his D.Sci. degree (first Habilitation in Skoltech).

- The center signed 12 joint research contracts with university partners, including Heriot Watt University, Calgary University, The University of New South Wales, Curtin University, Bashkir State University, the Institute of Petroleum Geology and Geophysics (RAS), Lomonosov Moscow State University, Gubkin Oil and Gas University, and the Moscow Institute of Physics and Technology;
- Over 50 publications indexed in the Scopus, Web of Science and One-Petro databases were published or in press in international scientific journals (in English) and in Russian oil industry journals in 2017.

Education

- The Center delivered eight courses on various Petroleum Science and Engineering disciplines with the participation of faculty from world-leading universities in the area of petroleum engineering;
- 32 MSc and PhD students were admitted to the Petroleum Engineering program in

Value generation

Application of research results for the development of new technologies and the application of new technologies in the oil and gas industry:

- Attracted more than 120 million rubles in external financing in the framework of contracts executed in 2017 and planned for 2018-2019;
- More than 30 contracts with industry, amounting to more than 130 million rubles in 2017;

Cooperation & Serving wider community

Prof. Mikhail Spasennykh

- Head of Expert Group on innovation in oil and gas of the Commission on Technological Development of Russia's Economy under the Russian President;
- Head of PhD program committee of Skoltech PhD Petroleum Engineering Program;
- Member of consulting board on the oil and gas industry (Skoltech);
- Member of Society of Petroleum Engineering;

- 2017, 51 students in total are studying at the programs (as of the end of the year);
- The CREI delivered more than 10 trainings for oil and gas companies

Research infrastructure

In 2017, the CHR opened its new world-class research facilities in Skolkovo Renova lab building. The facilities include:

- An unconventional petrophysics lab,
- A reservoir geochemistry lab,
- A geomechanics lab,
- A lab for enhanced oil recovery (chemical, thermal, gas and hybrid methods), and
- A gas hydrate and permafrost lab.

In 2017, the CHR laboratory was visited by members of Russia governments, as well as heads of Russian and international oil and gas companies. As a result, the center's collaborations with the oil and gas industry (i.e. number of contracts and total contract amount) expanded considerably.

- Close collaboration in the framework of research contracts with leading Russian and foreign oil and gas companies, including, Gazprom Neft, Lukoil, Rosneft, Gazprom, Novatek, Total, IBM and others.
- Well balanced structure of commercial contracts, including experimental research (50% of contract amount), theoretical studies (40%), and consulting services (10%).

Member of European Association of Geoscientists and Engineers;

- Organization of more than 50 joint events with industry (workshops, trainings, opening lab and so on); and
- Reviewer in scientific journals.

Prof. Andrei Osiptsov

- Serving on the expert group on Computer Science, IT & Numerical Math of the Faculty Appointment Committee of Skoltech



- Academic Council (selection of Faculty for CDISE);
- Serving on the Committee for Research Projects and Programs (CRPP) of Skoltech Academic Council;
- Member of consulting board on the oil and gas industry;
- Ad hoc reviewer for several journals:
 - o Journal of Petroleum Science and Engineering (5 papers),
 - o Journal of Fatigue (1),
 - o Physics of Fluids (1),
 - o Advances in App Maths (1), and
 - o Thermal Physics and Aeromechanics (1).

Prof. Yuri Popov

- Member of Skoltech Appointment Committee in 2016-2017;
- Member of consulting board on the oil and gas industry;
- Head of State Examination Commission of RSGPU-MGRI;
- Member of Council on PhD and Dissertations Defending in RSGPU-MGRI;
- Member (Past-Chairman) of International Heat Flow Commission (IASPEI);
- Member of Scientific Council “Problems of Geothermics” of RAS;
- Member of Russian Academy of Natural Sciences;
- Expert of RFBR; and
- Reviewer for journals Geothermics, Rock Mechanics & Rock Engineering, Geophysical Journal International, AAPG Bulletin, Geology and Exploration, Russian Geology and Geophysics.

Prof. Dmitri Koroteev

- Member of consulting board on the oil and gas industry;

Organization and participation in visible conferences, symposia, etc.

Prof. Mikhail Spasennykh

- Member of Program committee of EAGE/ SPE Joint Workshop 2017. “Shale Science: Prospecting & Development;”
- Member of Program committee of the conference GeoEurasia: Conference and Exhibition (GECE 2018);

- Member of Society of Petroleum Engineering;
- Member of European Association of Geoscientists and Engineers;
- Reviewer in a number of scientific journals.

Prof. Artem Myasnikov

- Member of Skoltech expert panel on Mechanical and Petroleum Engineering;
- Member of consulting board on the oil and gas industry;
- Member of PhD committee on Petroleum Engineering program;
- Member of Society of Petroleum Engineering;
- Member of European Association of Geoscientists and Engineers;
- Reviewer in a number of scientific journals.

Prof. Marwan Charara

- Member of consulting board on the oil and gas industry;
- Member of Society of Petroleum Engineering;
- Member of European Association of Geoscientists and Engineers;
- Member of the Society of Exploration Geophysicists (SEG) Research Committee; and
- Review for the journal Geophysics.

Prof. Alexey Cheremisin

- Member of consulting board on the oil and gas industry;
- Member of Skoltech education committee;
- Member of Society of Petroleum Engineering;
- Member of European Association of Geoscientists and Engineers.

- More than 50 events with industry (Unconventional hydrocarbons and other topics).

Prof. Alexey Cheremisin

- Member of Program committee of Moscow SPE conference, October 2017;
- Member of Program committee of Thermal



- EOR conference, Kazan, 2017;
- Moscow SPE conference, October 2017;
- More than 30 events with Industry (Enhanced recovery).

Prof. Marwan Charara

- Chairman of the European Association of Geoscientists and Engineers (EAGE) Conference 2017 in Paris (session: Seismic Modelling – Anisotropic and Viscoelastic);
- More than 10 events with Industry (geophysics).

Prof. Yuri Popov

- Member of Program committee of International conference “Geomodel-2017”;
- Chairman of the session “Experimental Geothermics” within IAG-IASPEI Joint

Scientific Assembly in Kobe, Japan, July 30-August 4, 2017;

- Chairman of the session “Petrophysics” within International EAGE conference “Geomodel-2017,” September, Gelendzhik, Russia;
- Chairman of three sessions within International EAGE conference “Geomodel-2017,” September, Gelendzhik, Russia;
- Chairman of a session within the EAGE conference in Moscow, April, 2017; and
- More than 30 events with Industry (thermal petrophysics).

Prof. Dmitri Koroteev

- More than 20 events with industry related to machine learning; and
- More than 10 lectures at student events (Tyumen, Ufa, Moscow).



GORDON MOORE

Professor at Skoltech and University of Calgary:

“Skoltech has assembled world-class EOR laboratory facilities which provide graduate students with opportunities to perform experiments on leading-edge equipment and to use this data as input to numerical simulation studies on a wide variety of recovery techniques.”

CENTER FOR ELECTROCHEMICAL ENERGY STORAGE

Director

Prof. **Keith Stevenson**

Research directions

Thrust 1. Advanced metal-ion batteries
Thrust 2. Rechargeable metal-air batteries
Thrust 3. Fuel, electrolysis, redox flow cells
Thrust 4. Organic and hybrid solar cells
Cross-cutting Thrust: Computational materials discovery, screening, modeling and simulation



Academic Excellence

Research within the CEE consists of the main four thrusts that parallel key areas of global trends, market forecasts, anticipated industry size, expected growth, and targeted opportunities by 2025-2040. The factors driving the growth of the energy storage market are progress in renewable energy power generation, rapidly increasing grid scale energy storage market, drop in prices of lithium-ion batteries and the growing application of energy storage in various end-user industries.

Research highlights

Over 70 publications indexed in Web of Science were published or in press in high impact factor journals in 2017. Selected examples include:

- S. A. Adonin, L.A. Frolova, M. N. Sokolov, G. V. Shilov, D. V. Korchagin, V. P. Fedin, S. M. Aldoshin, **K. J. Stevenson, P. A. Troshin**, Antimony (V) complex halides: lead-free perovskite-like materials for hybrid solar cells. *Adv. Energy Mater.* **2017**, 7, 1701140.

- A. F. Akbulatov, S. Luchkin, L. A. Frolova, N. N. Dremova, **K. J. Stevenson, P. A. Troshin**, Probing the intrinsic thermal and photochemical stability of the hybrid and inorganic lead halide based perovskites. *J. Phys. Chem. Lett.* **2017**, 8, 1211.
- S. Fedotov, A. Kabanov, N. Kabanova, V. Blatov, **A. Zhugayevych, A. Abakumov**, N. Khasanova, E. Antipov. Crystal Structure and Li-Ion Transport in $\text{Li}_2\text{CoPO}_4\text{F}$ High-Voltage Cathode Material for Li-Ion Batteries. *J. Phys. Chem. A* **2017**, 121(6), 3194.
- J. E. Coughlin, **A. Zhugayevych**, M. Wang, G. C. Bazana and **S. Tretiak**, "Charge delocalization characteristics of regioregular high mobility polymers," *Chem. Sci.* **2017**, 8, 1146.
- P. E. Pearce, A.J. Perez, G. Rousse, M. Saubanère, D. Batuk, D. Foix, Eric McCalla, **A. M. Abakumov**, G. Van Tendeloo, M.-L. Doublet, J.-M. Tarascon, Evidence for anionic redox activity in a tridimensional-ordered Li-rich positive electrode $\beta\text{-Li}_2\text{IrO}_3$, *Nature Materials*, **2017**, 16, 580–586.
- M. Morita, J. Klos, **A. A. Buchachenko**, and T. V. Tscherbul, Cold collisions of heavy $^2\Sigma$ molecules with alkali-metal atoms in a magnetic field: Ab initio analysis and prospects for sympathetic cooling of $\text{SrOH}(^2\Sigma)$ by $\text{Li}(^2\text{S})$, *Phys. Rev. A*, **2017**, 95, 063421.
- Dong X., **Oganov A.R.**, Goncharov A.F., Stavrou E., Lobanov S., Saleh G., Qian G.R., Zhu Q., Gatti C., Deringer V., Dronskowski R., Zhou X.-F., Prakapenka

V., Konopkova Z., Popov I., Boldyrev A.I., Wang H.T, A stable compound of helium and sodium at high pressure. *Nature Chemistry* **2017** 9, 440-445.

- Zakaryan H.A., Kvashnin A.G., **Oganov A.R.**, Stable reconstruction of the (110) surface and its role in pseudocapacitance of rutile-like RuO_2 . *Sci. Rep.* **2017**, 7, 10357.

Education

Over nine courses available with licensed and accredited MSc and PhD programs in Materials Science and Engineering. Approximately 50 MSc and PhD CEE students were enrolled in the programs as of the end of 2017.

- Courses: Materials Chemistry, Survey of Materials, Materials Characterization, Organic Materials, Computational Materials, Electrochemical Methods, Energy Colloquium, Energy Seminar
- 2nd Conference for Young Scientists (90 Academic & Industry participates)
- 18 new MSc students and 10 PhD students were recruited for fall 2017 enrollment.

Research infrastructure

Solar and Battery prototyping, in operando characterization, battery and fuel cell testing, high throughput material synthesis and characterization facilities, computational resources ranging from classical molecular dynamics to ab initio quantum chemistry.

A pilot scale battery manufacturing facility will be operational March 2018.

Value generation

Several breakthrough materials discoveries have already been made and are in the process of further development and patenting. Five invention disclosures were filed with Skoltech KTO in 2017. Three companies have been formed. One company (Rustor) will commercialize cathodes for Li-ion batteries; another company (yet to be named) will

develop materials for both aqueous and non-aqueous redox flow batteries in Russia. A third company (APC Complex) founded by A. Oganov focuses on material discovery with the USPEX code. Also, ongoing discussions with Bosch, LG electronics, Rusal and others are considering the establishment of joint laboratories at Skoltech.

Cooperation & Serving wider community

- Prof. Keith Stevenson**

 - Member of a working group on NTI e-mobility
 - Program manager for NGP
 - Program manager for SBI
 - Co-organizer of joint MIT-Skoltech conferences (1st, 2nd, and 3rd meetings)
 - Editorial Board Member of ACS Advanced Energy Materials.
- Prof. Artem Abakumov**

 - Member of a working group on NTI e-mobility
 - Chair of the Special Interests Group on Aperiodic Crystals of the European Crystallographic Association.
 - Chair of the C02 Review Committee of the European Synchrotron Radiation Facility.
- Prof. Artem Oganov**

 - Award Committee, RUSNANOPRIZE
 - Member of Russian delegation and
- panelist at sessions “AI and Manufacturing” and “Global innovation: A View from Russia” at the World Economic Forum (Dalian, June 2017)

 - Organizing Committee, “Science of the Future” conference of the Ministry of Education and Science
 - Member of the Russian President Council on Science and Education
- Prof. Alexey Buchachenko**

 - Board member of Russian Science Foundation
 - Chair of an Expert Panel of the Commission on the Assessment of the Performance of Scientific Organizations under the Federal Agency of Scientific Organizations (in Physical Chemistry, Chemical Physics, Polymers reference group)

Organization and participation in visible conferences, symposia etc.

- CEE faculty are highly visible organizers and participants in international conferences (over 30 invited talks). Selected examples include:
- (Invited talk) **Prof. Artem Abakumov**, Quantitative electron diffraction for metal-ion battery materials, 24th Congress of the International Union of Crystallography, Hyderabad, India, August 21-28, 2017.
 - (Conference co-organizer) **Prof. Artem Abakumov** “Crystallography of materials for energy,” at 24th Congress and General Assembly of the International Union of Crystallography, Hyderabad, August 2017.
 - (Conference co-organizer) **Prof. Artem Abakumov** II International research conference “Magnetic nanomaterials in biomedicine: synthesis, properties, applications,” Zvenigorod, September 2017.
 - (Invited talk) **Prof. Keith Stevenson** “Tuning the Electrocatalytic Activity of Perovskite Oxides for Water Oxidation and Oxygen Reduction by Active Site Variation” 253rd ACS National Meeting, San Francisco, CA, April 2017.
 - (Invited talk) **Prof. Keith Stevenson** “Understanding Ion Solvation Structure, Energetics and Kinetics in Super-concentrated Electrolytes for Energy Storage,”16th European Conference on Solid State Chemistry, University of Strathclyde, Scotland, July 2017.
 - (Conference co-organizer) **Prof. Keith Stevenson** “Synthesis & Characterization of Materials for Energy Applications,” 253rd Meeting of the American Chemical Society, San Francisco, CA, April 2017

CENTER FOR ENERGY SYSTEMS

Director	Prof. Keith Stevenson
Research directions	Smart Grids Integrated Energy Infrastructures Energy Markets and Regulation Power Electronics and Devices

Academic Excellence

- CES has established itself as an internationally-leading center of research on advanced mathematical methods for energy systems and as an internationally-recognized center of research on energy system integration. Over 30 publications indexed in Scopus were published in 2017 (13 accepted for publication). Examples of journal publications include:
- **M. Ali, A. Dymarsky**, K. Turitsyn: Transversality Enforced Newton Raphson Algorithm for Fast Calculation of Maximum Loadability. IET Generation, Transmission Distribution, pp. 1–9, December 2017
 - **F. M. Ibanez**: “Analyzing the Need for a Balancing System in Supercapacitor Energy Storage Systems,” IEEE Trans. Power Electronics, v. 33 (3)
 - X. Wang, **J. Bialek**, K. Turitsyn: “PMU-Based Estimation of Dynamic State Jacobian Matrix and Dynamic System State Matrix in Ambient Conditions,” IEEE Trans. Power Systems, v. 33
 - **D. E. Titov**, G. G. Ugarov, **A. A. Ustinov**: “Analysis of Application of Models to Assess Parameters of Ice Formation on Overhead Electric Power Lines,” Power Technology and Engineering, v. 51
 - **A. Sveshnikova, K. Abrosimov, A. Khayrullina, A. Ustinov**: “Effect of ambient air conditions on PEM fuel cell performance,” Journal of Renewable and Sustainable Energy, v. 9 (4)
 - N. Voropai, V. Stennikov, S. Senderov, E. Barakhtenko, O. Voitov, **A. Ustinov**: “Modeling of Integrated Energy Supply Systems: Main Principles, Model, and Applications,” Journal of Energy Engineering, v. 143
 - **M. Chertkov**, V. Chernyak: “Ensemble of Thermostatically Controlled Loads: Statistical Physics Approach,” Scientific Reports, v. 7
 - **D. Pozo**, E. Sauma, J. Contreras: “When doing nothing may be the best investment action: Pessimistic anticipative power transmission planning,” Applied Energy, v.200
 - **P. Vorobev**, P.H. Huang, M. Al Hosani, J. L. Kirtley, K. Turitsyn: “High-Fidelity Model Order Reduction for Microgrids Stability Assessment,” IEEE Trans. Power Systems, v. 33
 - **F. M. Ibanez**, E. Jose, F. Luis: “Master–slave DC droop control for paralleling auxiliary DC/DC converters in electric bus applications,” IET Power Electronics, v.10
 - **S. Briola**, P.Di Marco, R. Gabbrielli, J. Riccardi: “Thermodynamic sensitivity analysis of a novel trigeneration thermodynamic cycle with two-phase expanders and two-phase compressors,” Energy, v.127
 - **S. Briola**, P.Di Marco, R. Gabbrielli, J. Riccardi: “Sensitivity analysis for the energy performance assessment of hybrid compressed air energy storage systems,” Applied Energy, v. 206
 - Y. Apertet, **H. Ouerdane**: “Small-signal model for frequency analysis of thermo-



electric systems,” *Energy Conversion and Management*, v.149

- Y. Apertet, **H. Ouerdane**, C. Goupil, Ph. Lecoer: “True nature of the Curzon-Ahlborn efficiency,” *Physical Review E*, v. 96 (2)
- C. Elsid, **A. Bischi**, P. Silva, E. Martelli: “Two-stage MINLP algorithm for the optimal synthesis and design of networks of CHP units,” *Energy*, v.121
- C. Bustos, E. Sauma, S. de la Torre, J. Aguado, J. Contreras, **D. Pozo**: “Energy storage and transmission expansion planning: substitutes or complements?” *IET Generation, Transmission & Distribution*, 2017
- S.A. Dyachenko, A. Zlotnik, A.O. Korotkevich, and **M. Chertkov**: “Operator Splitting method for simulation of dynamic flows in natural gas pipeline networks,” *Physica D* 2017, v. 361
- V.Kovaleva, **Y. Maximov**, S. Nechaev, O. Valba: “Peculiar spectral statistics of ensembles of trees and star-like graphs,” *Journal of Statistical Mechanics: Theory and Experiment* 2017

Grants, awards and honors received in 2017:

Value generation

- Two industry R&D contracts signed in 2017 for 13.5 million rubles in total:
 - PJSC “IDGC of Urals” (daughter company of PJSC Rosseti) “Technology of condition diagnostics of insulators of overhead lines and switchgears 6-220 kV by the method of ultraviolet control”;
 - “MAP Maker” for PJSC Rosseti.

1.Prof. David Pozo. *Energy Systems Planning for Government Regulations: New Formulations, Models and Algorithms*. Next Generation Program: Skoltech-MIT Joint Projects award.

Education

CES developed a balanced curriculum for the 2017/2018 academic years and introduced five new courses. Now all courses are delivered by CES faculty members. In total, 17 MSc students and 25 PhD students were supervised, and 10 new MS students and 11 PhD students enrolled in fall 2017.

Research infrastructure

- Microclimate control lab created and commissioned under Skoltech-MIT NGP; Room 403 has been equipped with sensors and actuators to control room climate in an energy efficient way and test optimized control strategies, including Reinforcement Learning ones.
- Power electronics lab for education and research purposes has been created as a part of the Smart Grid Lab. Half of the “Power electronics” course (F. Ibanez) is held in that lab, including guided experiments and experimental projects

- “Monitoring ice conditions in the regional electric network”
- FONDAZIONE BRUNO KESSLER (FBK, Italy): PhD studentship at CES.
- A2A multi-utility group and OPTIT consultancy company: MoU for bidding to European Bank of Reconstruction and Development (EBRD) tender in Kazakhstan.

Cooperation & Serving wider community

Prof. Janusz Bialek

- Editorial Board of special section on Energy System Integration, *IEEE Trans. Smart Grids*;
- International Scientific Advisory Board,

National Centre for Energy Systems Integration (United Kingdom);

- Advisory Editorial Board, *International Journal of Electrical Power and Energy Systems*.

Prof. Aldo Bischi

- Guest editor on Integrated Energy Infrastructure, *Energy the international journal*; and
- NGP project lead.

Prof. Elena Gryazina

- Organizer of the 9th Traditional Summer School “Control, Information and Optimization” June 14-20, 2017 (Institute for Control Sciences, Higher School of Economics, Skoltech);
- Guest editor for special issue “Traditional school on control, information and optimization” in *Advances in System Science and Applications*, 17(3), 2017.

Prof. Mikhail Chertkov

- Editorial Board of the *Journal of Statistical Mechanics*, JSTAT;
- Editorial Board of *Scientific Reports*, Nature Group;
- Editorial Board of *IEEE CONES* (Control of Networks); and
- Editor for the special Issue of *IEEE CONES* on “Special Issue 2019: Analysis, Control and Optimization of Energy System Networks.”

Prof. Yury Maximov

- Editorial Board of *Lecture Notes on Computer Science* (Springer), special issue on Intelligent Data Processing Conference (IDP-16).

Organization and participation in visible conferences, symposia, etc.

- CES organized its 3rd International Conference “Science for Energy Systems Regulation,” at Skoltech in October 2017, for over 40 participants and nine invited international experts.
- Examples of international conferences (invited talks) CES faculty and researchers have been invited to:
 - Prof. Janusz Bialek in Manchester (United Kingdom)
 - Prof. David Pozo: VII Workshop of Energy Economy, “Reliable Integration of Renewable Energy to Support Climate Mitigation” (Chile)
 - Prof. Mikhail Chertkov IREP 2017, September. Porto (Portugal)
 - Prof. Mikhail Chertkov NIPS 2017 (December, Long Beach, CA), CDC 2017 (December, Melbourne)
 - Prof. Yuri Maximov NIPS 2017 (December, Long Beach, CA),
 - Prof. Yuri Maximov “55th Allerton Conference 2017” (October, Chicago, IL)
 - Dr. Dmitri Titov “Ice monitoring system for overhead transmission lines,” Corporate presentation day JSK MRSK North-West (Rosseti), St. Petersburg, Russia, November 2017.
 - Dr. Dmitri Titov “Development of Skoltech Center for Energy Systems in the field of electrical equipment diagnostics “CYBERNETICS OF ENERGY SYSTEMS,” Novocherkassk, November 2017.
 - Andrey Churkin (PhD student), “Joint Conference on Northeast Asia Regional Power Interconnection,” Irkutsk, Russian, August 2017
 - Ksenia Letova, “Trilateral expert meeting “Russia-Japan-United States,” March 2017.



KEITH STEVENSON

Dean of Research, Director of CEE and CES:

“The idea of the [Skoltech Center for Electrochemical Energy Storage] is really to help provide the capabilities to modernize the tech base in Russia so that they can make their own batteries and other energy storage devices and can source their own materials and make their own solar cells and not rely on an import base, and they can also diversify their energy network.”



CENTER FOR PHOTONICS AND QUANTUM MATERIALS

Director	Prof. Mikhail Skvortsov
Research directions	Carbon nanomaterials Hybrid photonics Plasmonics Biophotonics Superconducting quantum technologies Ultra-precise clock

Academic Excellence

Research highlights

In 2017, CPQM faculty and researchers prepared over 50 papers either published or in press in high impact factor journals. A list of selected papers includes:

- S. Rackauskas, S. D. Shandakov, H. Jiang, J. B. Wagner, **A. G. Nasibulin**, *Direct observation of nanowire growth and decomposition*, Scientific Reports **7**, 12310 (2017).
- E. P. Gilshteyn, D. Amanbayev, A. S. Anisimov, T. Kallio, **A. G. Nasibulin**, *All-nanotube stretchable supercapacitor with low equivalent series resistance*, Scientific Reports **7**, 17449 (2017).
- L. Dobusch, S. Schuler, **V. Perebeinos**, and T. Mueller, *Thermal Light Emission from Monolayer MoS2*, Adv. Materials **29**, 1701304 (2017).
- **N. G. Berloff**, M. Silva, K. Kalinin, A. Askitopoulos, J. D. Töpfer, P. Cilibizzi, W. Langbein and **P. G. Lagoudakis**, *Realizing the classical XY Hamiltonian in polariton simulators*, Nature Materials **16**, 1120 (2017).
- T Cookson, K Georgiou, A Zasedatelev, R. T. Grant, T Virgili, M Cavazzini, F. Galeotti, C. Clark, **N. G. Berloff**, D. G. Lidzey, and **P. G. Lagoudakis**, *A Yellow Polariton Condensate in a Dye Filled Microcavity*, Adv. Optical Mater. 1700203 (2017).

- **A. Chipouline** and F. Küppers, Analytical qualitative modelling of passive and active metamaterials (invited), JOSA B **34**, 1597 (2017).
- B. Dutta, J. T. Peltonen, D. S. Antonenko, M. Meschke, **M. A. Skvortsov**, B. Kubala, J. König, C. B. Winkelmann, H. Courtois, J. P. Pekola, *Thermal Conductance of a Single-Electron Transistor*, Phys. Rev. Lett. **119**, 077701 (2017).
- A. S. Timin, M. M. Litvak, **D. A. Gorin**, E. N. Atochina-Vasserman, D. N. Atochin, G. B. Sukhorukov, *Cell-based drug delivery and use of nano- and microcarriers for cell functionalization*, Advanced Healthcare Materials, Nov. 30 (2017).

Internal grants:

- 4 NGP Skoltech-MIT grants “Investigations of high-temperature cuprate superconductors and other quantum materials” (prof. Boris Fine), “Next Generation Research Partnerships: Current Progress and Future Opportunities” (prof. Albert Nasibulin), “Polaritonics providing a paradigm shift in optoelectronics” (prof. Pavlos Lagoudakis / prof. Natalia Berloff), “Quantum materials for superconducting nanophotonics” (prof. Mikhail Skvortsov)
- 2 projects at Skoltech Translational Research Innovation Program (STRIP) (prof. Albert Nasibulin)

External funding:

- Russian Science Foundation grants “New generation of transparent, conductive, flexible and stretchable films of single-walled carbon nanotubes produced by aerosol CVD synthesis method” (prof. Albert Nasibulin), “Statistical behavior of thermally isolated quantum systems” (prof. Boris Fine), “Quantum adiabaticity in many-body systems” (Dr. Oleg Lychkovsky)
- The ERA-NET Plus project (under European Union program Horizon 2020) “Flexible hybrid heterojunction nanostructures for optoelectronic applications” (Germany, Estonia and Russia). Ministry of Science and Education of Russian Federation. (prof. Albert Nasibulin)
- Bortnik foundation Start-Skolkovo program winners: “Fabrication of taggants for industrial explosives” (prof. Albert Nasibulin).

Education

12 courses available with licensed and accredited MS and PhD program. Approximately 30 MS and 22 PhD students are enrolled in PQM programs.

- **Courses:** Quantum Mechanics, Advanced Quantum Mechanics, Introduction to Solid State Physics, Advanced Solid State

Value generation

Two high-impact industrial projects supported within subsidies (contracts under Federal program Research and development in priority areas of development of Russia’s scientific and technological complex for 2014-2020 (1.4) of the Russian Ministry for Education and Science are running at CPQM: “Development of technologies and components of integrated microwave photonics” (as part of consortium of MEPhI, Skoltech & NSU) and “Development of ultrastable reference signal generator based on cold Yb ions for increased precision GNSS applications” (as part of consortium

Physics, Fundamentals of Photonics, Hybrid Photonics, Nanooptics, Non-linear Optics, Fiber Optics, Biomedical Application of Photonics, Fundamentals Device Physics, Carbon nanomaterials.

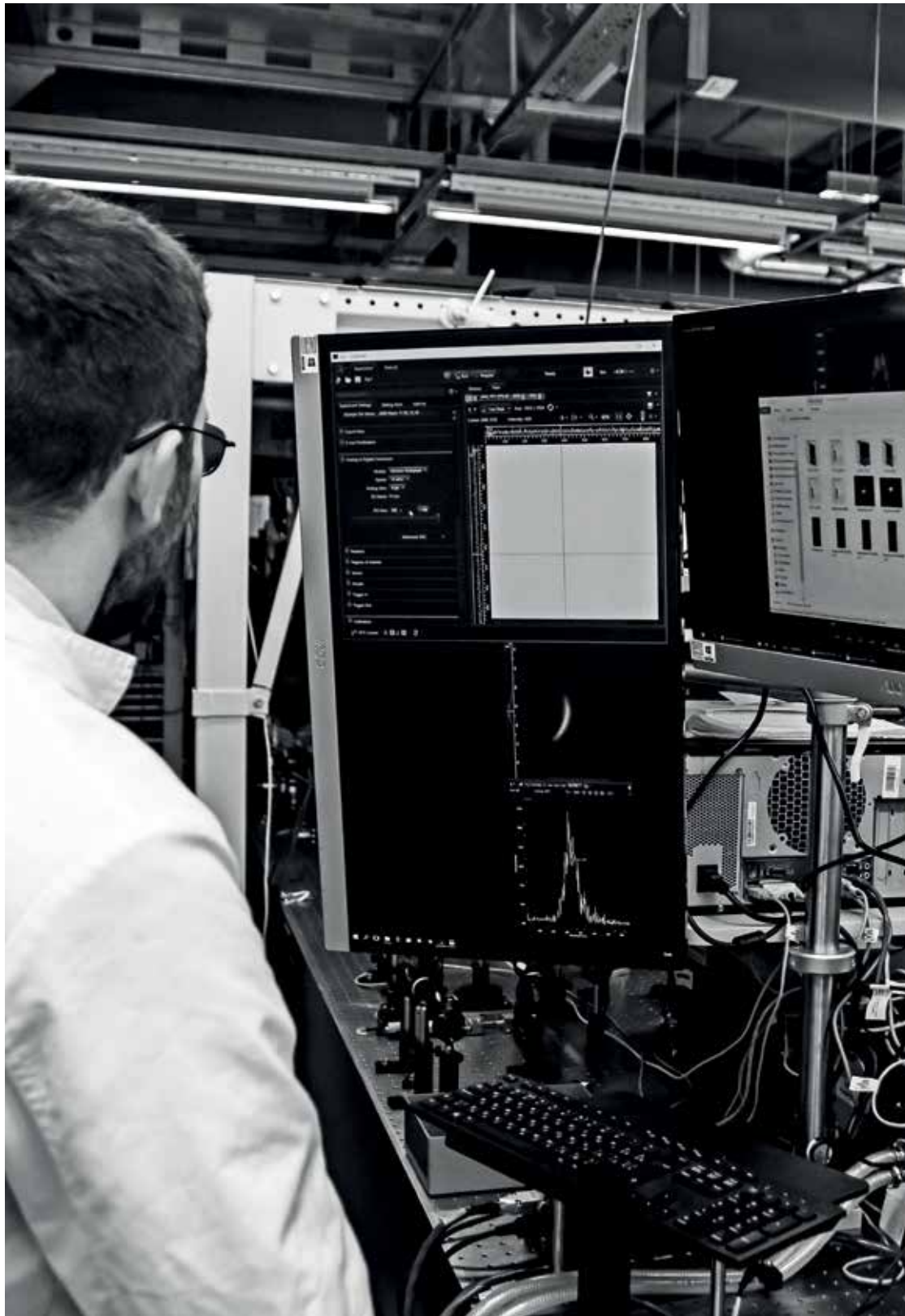
- Twenty new MS students and 10 PhD students were recruited for Fall 2017 enrollment.

Research infrastructure

- The Hybrid Photonics Laboratory, including small “clean room” facilities, is fully functional;
- The Nanomaterials Laboratory, with six research project groups, is fully functional;
- The research infrastructure for the Nanoplasmonics Laboratory has been established;
- The Biophotonics Laboratory research concepts have been approved, a research infrastructure has been established, and purchases have been initiated; and
- The research infrastructure for the project “Development of ultrastable signal generator to increase by order of magnitude precision of geolocation, space navigation and to form new mass market segments of GNSS applications” has been established.

of Lebedev Physical Institute, Russian Space Systems, Institute of Laser Physics SB RAS & Avesta Ltd).

The start-up company “CryptoChemistry” was established. Three patent application were submitted and two patents granted. Ongoing discussions and cooperation are under way with RTI, RSS, T8, HUAWEI, Sberbank, Voentelecom, IPG Photonics, En+ Group, RUSAL, IBM, Connector Optics, Varton, Lassard, Cambridge Quantum Computing company, Moscow Oncology Research Institute, Jenoptik, LASSOS (Germany).



Cooperation & Serving the wider community

- A series of PostNauka online lectures in photonics (prof. Ildar Gabitov, prof. Nikolay Gippius, prof. Vasily Perebeinos)
- Lectures in Physics for educational center Sirius, Sochi (prof. Boris Fine, prof. Nikolay Gippius).
- Member of the consulting group of the federal initiative "Digital Economy";
- Steering committee of the Project "Multiply," United Kingdom (prof. Arkady Chipouline).
- Member of Advisory board on ESPRC Programme on Hybrid Polaritonics; Invited member of the Board of Directors of Schwinger Foundation (prof. Natalia Berloff).

Organization and participation in visible conferences, symposia, etc.

CPQM faculty members have organized and participated in many international conferences (over 40 invited talks).

Selected examples:

- (Co-organizer) **prof. Vasily Perebeinos** CleoEurope 2017 Two-dimensional Materials, Munich, Germany, June 2017;
- (Co-organizer) **prof. Boris Fine** Perspectives on High-Temperature Superconductivity, Skoltech, October 2017;
- (Co-organizers) **prof. Natalia Berloff** and prof. Pavlos Lagoudakis Conference on Hybrid Photonics and Materials, Mykonos, Greece, September 2017;
- (Invited talk) **prof. Dmitry Gorin** "Photonic tools for imaging & navigation of remote controlled theranostic carriers," 1st Nano-Bio materials and Raman characterization workshop, Ghent, Belgium, September 2017;
- (Invited talk) **prof. Arkady Chipouline** "Amplitude Noise Suppression and Orthogonal Multiplexing Using Injection-Locked Single-Mode VCSEL," Optical Fiber Communications, Los Angeles, United States, March 2017; and
- (Co-organizer) **prof. Mikhail Skvortsov**, Workshop on localization, interactions and superconductivity, Chernogolovka, Russia, December 2017.



ILDAR GABITOV
Professor, CPQM:

"Quantum technologies are an important element of our research and technology projects that have two principal drivers. First: theminiaturization of electronic devices underscores the need for addressing small-dimension quantum effects. Second, the evolution of technology, as such enables the use of remarkable features of the quantum world in a wealth of diverse applications."



CENTER FOR ADVANCED STUDIES

Director	Prof. Igor Krichever
Research directions	Mathematical Physics

Academic Excellence

Research within the CAS is focused mainly in the areas of geometric representation theory, string theory, conformal and gauge field theory, integrable models, combinatorics and singularity theory, symplectic geometry, topology, statistical physics, dynamical systems and hyperbolic geometry.

Research highlights

Over 40 publications indexed in Web of Science were published or in press in high impact factor journals in 2017.

Selected examples include

- **S. Lando**, V. Zhukov, “Delta-matroids and Vassiliev invariants”, Mosc. Math. J., 17:4(2017) 1-15
- **M. Kazarian, S. Lando**, D. Zvonkine, “Universal cohomological expressions for singularities in families of genus 0 stable maps”, Int. Math. Res. Notices rnx070, 2017
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Education

Over 17 courses are available with licensed and accredited MSc and PhD programs in Mathematical and Theoretical Physics. Approximately 17 MSc and PhD students are enrolled. Four PhD students are winners of the “Young Math of Russia” Call.

Selected courses:

- Lie Groups and Lie algebras and their representations,
- Hamiltonian mechanics,
- Geometric representation theory,
- Dynamical systems and Ergodic theory,
- Gauge theory and Gravitation,
- Differential topology,
- Random Processes,
- Integrable systems

Cooperation & Serving wider community

Prof. Igor Krichever

- Member of Expert Panel for European Research Council;
- Member of several Editorial Boards: International Mathematical Research Notes; Uspekhi Matematicheskix Nauk; Functional analysis and its applications.

Prof. Mikhail Finkelberg

- Member of the Editorial Board: International Mathematics Research Notices.

Prof. Sergey Lando

- Vice-President of the Moscow Mathematical Society,
- Member of the Editorial Board of the Moscow Mathematical Journal.

Prof. Andrei Marshakov

- Theoretical and Mathematical Physics, member of Editorial board; and
- Russian Fund for Basic Research, member of Expert panel for Mathematical Physics.

Prof. Grigory Olshanski

- Member of several Editorial Boards: Functional Analysis and its Applications; Transformation Groups; Journal of Lie Theory; SIGMA (Symmetry, Integrability and Geometry: Methods and Applications);
- Member of the Board of the Moscow Mathematical Society.

Prof. Semen Shlosman

- Member of Editorial Boards: Uspekhi Matematicheskix Nauk; Moscow Mathematical Journal.

Prof. Anton Zabrodin

- Member of the Editorial Board of “Analysis and Mathematical Physics.”

Dr. Anton Zorich

- Member of the Scientific Committee of Max-Planck-Institut for Mathematics, Bonn; and
- Member of Editorial Boards: Journal of Modern Dynamics; Journal of the Institute of Mathematics of Jussieu.

Organization and participation in visible conferences, symposia, etc.

The CAS faculty are highly visible organizers and participants in international conferences (over 50 invited talks). In 2017 the following conferences and Workshops were organized by CAS:

- Conference “**Contemporary Mathematics**”, Moscow, December 14–23, 2017
- Conference “**Transformation groups**”, Moscow, December 14–18, 2017
- Workshop “**Quantum Information and Topological Recursion**”, Moscow, June 19-23, 2017
- Workshop “**Moduli Spaces in Moscow:**

- Dynamics and Geometry**”, Moscow, June 5-9, 2017
- Mini-course “**Random Matrices and Extreme Value Statistics**”, Moscow, May 22-23, 2017
- Student workshop “**Representation Theory and Integrable Systems**”, Amsterdam, May 15-24, 2017
- Second Workshop “**Critical and Collective Effects in Graphs and Networks**” Moscow, May 15-19, 2017
- Second school-conference “**String Theory, Integrable Models and Representation Theory**” Moscow, January 21–27, 2017



IGOR KRICHEVER
Director, CAS:

“Skoltech, with its multidisciplinary approach, is the ideal choice: offering graduates knowledge with clear, real application. Successful graduates of our master’s program can be confident that they will obtain spots at our postgraduate school, but we also hope they will be sought after candidates at leading scientific centers abroad.”

Skolkovo Innovation Ecosystem & Wider Community

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Skolkovo Ecosystem



Programs for Gifted School Kids and Undergraduates

In 2017 Skoltech significantly broadened its engagement with the ecosystem of both the Skolkovo Innovation Center and Skolkovo Education Hub, a joint venture with Moscow School of Management Skolkovo (MSM Skolkovo) and the New Economic School (NES).

Skolkovo Innovation Center

Throughout 2017, Skoltech faculty, students and staff have had multiple and continued engagement with residents of the Skolkovo Innovation Center, Technopark Skolkovo and Skolkovo International Gymnasium.

In 2017, Skoltech and Skolkovo Gymnasium had two joint events in form of two lectures conducted between two institutions. The first lecture took place at the end of September, where Skoltech Professor N. Gippius read course «Theory of interaction between light and matter». Another lecture on topic of «Blackholes paradox» by Prof. Anatoly Dymarskiy took place on 13 of December 2017. Interactions with Skolkovo Gymnasium started by kick-off meetings last year, where major activities for implementation in future years were decided. For the year of 2018, expansion of variety of lectures by Skoltech professors and extra curriculum courses organized by master and PhD students of Skoltech is planned. These courses will be adopted to meet the education level of high school pupils. Furthermore, mentoring program of scientific projects by post graduates and professors of Skoltech will be initiated in 2018. Lastly, Skoltech managed to provide an opportunity to conduct master classes and workshops at Skoltech labs as well as providing our internal facilities in order to achieve the best mutual long-term collaboration.

Skoltech MSc and PhD students have conducted seminars for the Gymnasium students and organized visits and workshops at Skoltech laboratories. Skoltech faculty regularly speak at events organized by the Skolkovo

Technopark. Skoltech takes active part in all major events at the Skolkovo Innovation Center, including the Startup Village, Open Innovation Forum, Skolkovo AI conference, Skolkovo Jazz and more. Most of these events are held partially on the Skoltech campus and students are regularly engaged as volunteers. Various units of the Skolkovo Innovation Center held over 30 events on the Skoltech campus with the participation of the Skoltech community in 2017. These included investment competitions among Skolkovo residents and industrial partners, hackathons, visits of international business delegations and many others.

Skolkovo Education Hub (SEH)

On December 27, 2016, at the Sochi International Investment Forum, Skoltech signed an agreement with MSM Skolkovo and the NES, which set the framework for cooperation between the three institutions along the avenues of joint research, education and innovation activities. The Skolkovo Education Hub (SEH) aims to maximizing the synergetic effect of the three schools in order to create new joint educational products to be offered on the corporate education market as well as to benefit the students. In 2017, Skoltech faculty and leadership participated in multiple events held on all three campuses and were engaged in teaching courses offered by the MSM Skolkovo to its corporate clients. Joint faculty club meetings are held quarterly to identify areas of potential research collaboration. The three institutions participate in all major Skolkovo events under the umbrella of the SEH. The Institute is also a key element of the large project “Large Skolkovo”, a joint endeavour of Skoltech, MSM Skolkovo, NES, Millhouse Capital and the municipal authorities of Zarechie and Novoivanovskoe. The goal of the project is the overall joint development of the Skolkovo territory into an alternative intellectual and innovation agglomeration in Moscow.

SIRIUS

In March 2017, Skoltech began active cooperation with the Sirius Educational Center in order to evoke a sustainable interest in science among young people, raise the educational level of Sirius students and fulfill their scientific potential, involve Sirius students and graduates in advanced research projects, set up a round-the-year cooperation program to help young talents acquire competitive project skills and provide tutelage and mentoring by Skoltech faculty. In particular, the scope of cooperation covers the following activities.

- Implementation of in-depth core-discipline and interdisciplinary programs, including workshops at Skoltech leading labs and student projects;
- Engagement of Sirius graduates in the development and implementation of grant-funded R&D projects in the advanced fields of science and technology;
- Set up lectures for Sirius students in Sirius during educational shifts by Skoltech professors, researchers, heads of laboratories and employees;
- Set up online webinars for Sirius graduates in Sirius' e-learning environment by Skoltech leading researchers;
- Encourage Sirius graduates to participate in Skoltech events (conferences, tournaments, competitions, olympiads, etc.) aimed at promoting research and innovative activity;
- Encourage Sirius graduates to participate in other public cultural, awareness-raising, educational and industry events conducted by Skoltech independently or in partnership with other entities;
- Set up Sirius-based internship and student teaching programs for Skoltech students;
- Engage Skoltech staff in the implementation and expert assessment of student research and design projects;
- Contribute to the development and implementation of specialized educational programs based on the Sirius model for newly created regional talent discovery and support centers and participate in their activity;
- Provide information support for Sirius educational programs launched at schools cooperating with Skoltech;
- Establish links and information exchange as part of the campaign aiming to disseminate scientific knowledge, promote state of the art science and technology.



ALEXEI SITNIKOV

Vice President for Communications and Community:

“Skoltech is an essential element and the intellectual nucleus of the Skolkovo ecosystem. Professors, researchers, and students actively participate in the Innovation Center's key events.”



ALEXANDER SAFONOV

Vice President for Academic Development, Academic Secretary:

“One of Skoltech's priorities is to engage young talents in the world of big science and cutting-edge technologies.”

The following activities were held during the year:

DATE	BUILDING (LOCATION)
March 2017	Two lectures by prof. Konstantin Severinov related to (1) “genomic medicine” and (2) “Admission to Skoltech. Sirius, Sochi
April 2017	Four lectures of prof. Boris Fine. Sirius, Sochi
April 2017	Attendance of a joint conference hosted by Skoltech and MIT: Shaping the Future: Big Data, Biomedicine and Advanced Technology by Sirius graduates and employees
June 2017	Attendance and presentation of the projects of Sirius graduates during the Skolkovo Startup Village 2017
July 2017	Participation in the project shift Bolshie Visovi 2017 in the division of “agro - and biotechnology” by Skoltech biotechnology students as project coordinators
July 2017	Participation of Skoltech employees in in the project “Big challenges 2017” as experts during final presentations of project teams
July 2017	Preparation of reviews of viewed project presentations during project shift “Big challenges 2017”
August 2017	2 lectures of prof. Maxim Kiselev related to (1) How to make a successful presentation (2) Basis of innovative entrepreneurship. Sirius, Sochi
August – September 2017	Organization and holding of remote-learning webinar: Turbo-science for Sirius graduates. Skoltech
September 2017	Organization and holding of an open lecture of prof. Nikolay Gippius on the topic “Theory of interaction of light and matter” for Sirius graduates, the recipients of presidential grants and the students of the Skolkovo gymnasium. Skoltech
September 2017	Audit of laboratories at the Science Park Sirius
October – December 2017	Conducting a pilot version of the distant tutoring program “Turbo-Science” for the graduates of the Center “Sirius.”
November 2017	A report on the status of the Sirius laboratory complex and the possibilities for its improvement
December 2017	Organization and holding an open lecture of prof. Anatoly Dymarsky on the topic “Black hole information paradox” for Sirius graduates, the recipients of presidential grants and the students of the Skolkovo gymnasium.
December 2017	Organizing and conducting of a lecture on the topic “About the human genome” by prof. Konstantin Severinov for math students in December 2017. Sirius, Sochi
December 2017-ongoing	A number of meetings were held with the head of the Talent and Success Foundation regarding the participation of Skoltech project teams in the project “Big challenges 2018” in the division of “Agro- and biotechnology.”
December 2017-ongoing	Preparation of the first draft of a cooperation agreement between Skoltech and the Talent and Success Foundation.

SUMMER SCHOOL

Within the activities for gifted school kids and undergraduate students Skoltech piloted the Summer School in Theoretical Physics, Bioinformatics and Molecular Biology (August 25th-September 4th). The School focused on exposing talented students to advanced research by providing the opportunity to work with leading scholars from Skoltech and its partners from Russia and abroad.

The School was attended by 42 students from 17 Russian universities, including Ufa Techniqal University, Ural Federal University, Saint Petersburg Academic University, Tuymen State University, Kazan Federal University, Baltic Federal University, Kemerovo State University, Volgograd State University and others. The selection of the participants was conducted by an organizing committee that comprised Skoltech faculty, as well as invited experts in the relevant fields:

1. Prof. Konstantin Severinov, Skoltech (CDIBB)

2. Prof. Mikhail Gelfand, Skoltech (CDIBB)

3. Prof. Mikhail Skvortsov, Skoltech (CPQM)

4. Prof. Gregory Falkovich, Weizmann Institute of Science

5. Prof. Leonid Levitov, MIT

6. Dr. Mikhail Feigelman, Landau Institute of Theoretical Physics and CPQM at present

7. Dr. Elizaveta Boch-Osmolovskaya, Research Center of Biotechnology RAS

The School program was developed in a way to cover various activities, including lectures, seminars, individual mentoring sessions, a laboratory practicum (section “Molecular Biology”), projects and presentations of results, site visits to academic institutions and technoparks and self-study time. The study program was delivered by faculty and researchers from Russian and international universities and academic institutions (Skoltech, MIT, Delft TU, MSU, HSE, Landau Institute for Theoretical Physics, Stony Brook University, Weizmann Institute of Science and others).

Lectures of the Summer School

Section “Theoretical Physics”

Prof. Gregory Falkovich, Weizmann Institute of Science (Israel)

Prof. Leonid Levitov, MIT (United States)

Prof. Drmitry Kharzeev, Stony Brook University (United States)

Prof. Yulii Nazarov, Delft TU (Netherlands)

Dr. Dmitri Abanin, Russian Quantum Center (Russia)

Dr. Alexey Ioselevich, HSE (Russia)

Section “Bioinformatics”

Dr. Mikhail Tamm, HSE (Russia)

Dr. Andrei Mironov, MSU (Russia)

Dr. Sergey Ulianov, MSU (Russia)

Dr. Alexander Gorsky, Institute for Information Transmission Problem RAS (Russia)

Dr. Alexander Chertovich, MSU (Russia)

Dr. Sergey Nechaev, French National Center for Scientific Research (France)

Dr. Ekaterina Khrameeva, Skoltech (Russia)

Section “Molecular Biology”

Prof. KonstantinJ Severinov, Skoltech (Russia)

Dr. Elizaveta Boch-Osmolovskaya, Research Center of Biotechnology RAS (Russia)

Dr. A.Merkel, Research Center of Biotechnology RAS, “Biospark” company (Russia)

Dr. A. Slobodkin, Research Center of Biotechnology RAS (Russia)

Dr. G. Gitelzon, Institute of Protein Research RAS (Russia)

Dr.I. Kublanov, Research Center of Biotechnology RAS (Russia)

Dr. I. Tarnovetsky, MSU (Russia)

The School experience was positively rated by the students, who particularly enjoyed the unique opportunity to conduct scientific projects under the guidance of top level academics. The Summer School is planned to be held annually, and is expected to expand the number of thematic sections.

Campus and Administrative Support





Project and Construction Management-New Campus and Interim Facilities

- Delivery dates for the East Ring have been extended in accordance with the Foundation's decision. All move plans have been revised to 2018. This task will carry-over to the SAP. All lab designs and other project documentation in accordance with agreed schedules have been completed in full.
- All interim facilities and space plans have been delivered and completed and the budget has been fully executed

Space Planning and Management

- To the extent that local regulation allow, we have provided all necessary facilities for labs and materials management functions. Space has been allocated to all functions in accordance with available budget and Presidential directives.
- A basic system of projecting space needs has been implemented. An automated system is under development in conjunction with the back-office program to develop/implement automated business processes.

Facilities Management and Operations

- The development and execution of a cost-effective facilities management

plan that minimizes the down-time of engineering and support facilities is complete, but under continuous revision to improve performance on a regular basis, rather than on a periodic, project-type basis.

EHS

- The EHS policy has been revised, new lab safety plan developed and approved with Directors of "high-risk" labs identified during a regular audit in 2017.
- The EHS-audit plan has been revised with respect to labs, shared facilities and educational facilities complete and under review.

Real Estate Management

- Budget planning and execution of the control system are partially complete (budget planning system), with the remainder planned for 2018 in accordance with planning for automation of business processes
- Income-generating (where possible) profitable and leasing plan for available space in the East Ring. Preliminary plans indicated, and will be developed and approved for execution in 2018 in accordance with revised East Ring delivery schedule.

ADMINISTRATIVE SUPPORT

The goal of the Back Office is to provide financial and administrative services in support of the Institute's mission. The functions of recording financial transactions, safeguarding physical and financial assets, allocation of resources, human resources services, procurement, IT and legal compliance are handled by the Department of Financial Planning and Controlling, Finance Department, Office of Internal Control, IT Department, Legal Support Department, Procurement Department, along with appropriate financial and administrative systems.

Financial and operational resources

- A renewed financial concept was developed as the framework for budgeting and business intelligence system implementation in 2018, financial control and reporting on the Institute activities.
- An on-line cash office has been launched for events and short-term programs.
- An on-site audit for 2014-2016 was conducted by the Social Security Fund and Pension Fund of Russia. Skoltech was audited for 2014-2016.
- New approach for housing was developed and implemented. As a result, over 30 relocated Skoltech employees moved to the premises of Skolkovo Innovation Center.
- Updated Procurement Regulations were implemented for centralized procurement process.
- Total annual savings amounted to 15% (direct savings, calculated from initial maximum estimated prices) thanks to the implementation of standard competitive tendering procedures. The savings provided the Institute additional financial resources for projects and initiatives in its' core functions.

- The Back Office was in compliance with local legislation in all areas of operation, research, education and administration.
- The legal framework and set of legal documents were developed to ensure startup activities of the Institute.

Information systems improvement

- A budgeting IT system (IBM Cognos TM1) was implemented for quality process (including headcount).
- An Electronic Document Management System (EDMS – DIRECTUM) was introduced as an essential tool for building a complete document management solution tailored to the requirements of the Institute.
- Implementation of EDMS builds out an information infrastructure giving central control over operation content ensuring secure electronic documents archive, streamlining approval process, providing staff cooperation, improving operational effectiveness and clarity, cutting costs and reducing risks.
- Electronic archive. The conceptual approach and design of the archive was developed (to be implemented in 2018).

Reengineering of business processes.

Internal Control System

- Business process reengineering project (cross-functional) was conducted related to educational, research, operational, facilities management activities.
- Annual risk Assessment (Risk Register) was performed including the CREIs' and Departments' highest risks to the Institute. Risk mitigation action plan was developed for 2018.
- Internal control was documented and embedded into processes for further integration with IT infrastructure. Internal control policy was developed. Risk and Control Matrices were developed on the basis of business processes correction.

Financial Overview

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The section provides a review of Skoltech’s financial results for 2017 based on cash approach, as well as key issues related to management reporting.

OPERATING REVENUE SOURCES

In 2017, Skoltech received a total of 6 539.3 mln RUB in funding from various sources, as presented below. A Skolkovo Foundation Grant and income from the Endowment were the two largest sources of funding, representing 84% and 7% of total funding during the Fiscal Year 2017, respectively.

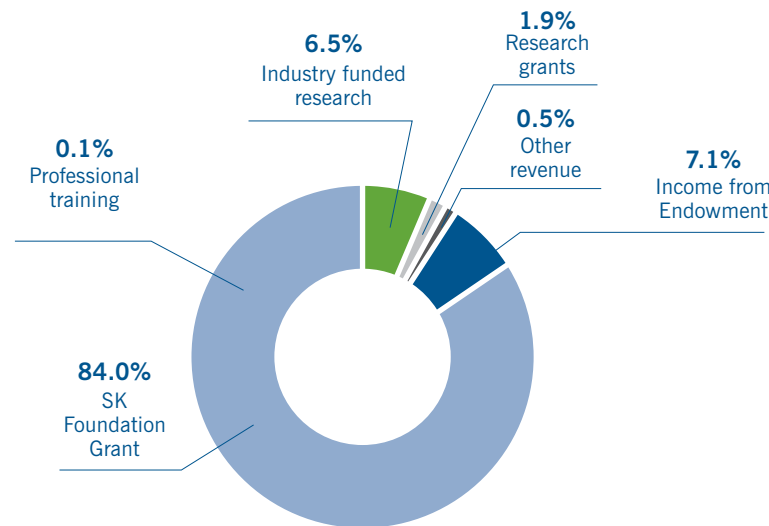


Figure 44. Institute's operating revenue by sources

In 2017, operating revenue amounted to 1 047.8 mln RUB, 114.5 mln RUB more than in 2016. The following table shows the key components of the revenue boost.

Table 15. Components of the Institute's revenue

	2016 ACTUAL MLN RUB	2017 ACTUAL MLN RUB	2017 BUDGET MLN RUB	2017 ACTUAL VS BUDGET%	ACTUAL 2017 VS 2016%
Operating revenue	933.27	1,047.80	1,092.20	-4%	12%
Professional training	0.00	4.80	0.00	–	–
Industry funded research	278.50	427.11	413.52	3%	53%
Research grants	69.56	122.77	85.85	43%	76%
Other revenue	114.77	32.07	117.42	-73%	-72%
Income from Endowment	470.45	461.05	475.42	-3%	-2%

A key reason for such a significant increase of operating revenue was the expansion of industry-funded research. In 2017, the Institute launched professional training programs that generated operating revenue totaling 4.8 mln RUB.

TOTAL EXPENSES

The Institute continues to manage its expenses responsibly, aligning institutional resources from all sources to support the execution of the Strategic Action Plan. In 2017, expenditures totaled 5 878.5 mln RUB, including capital investment projects (Fig. 45).

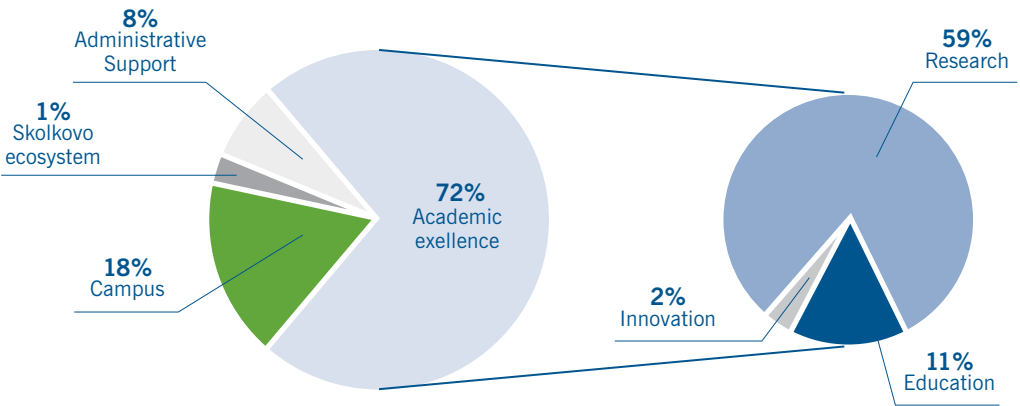


Figure 45. Institutes' expenses in 2017

OPERATING EXPENSES

In 2017, operating expenses amounting to 4 084.1 mln RUB were derived from the categories shown below (Fig.46) and were 458.5 mln RUB higher than in 2016.

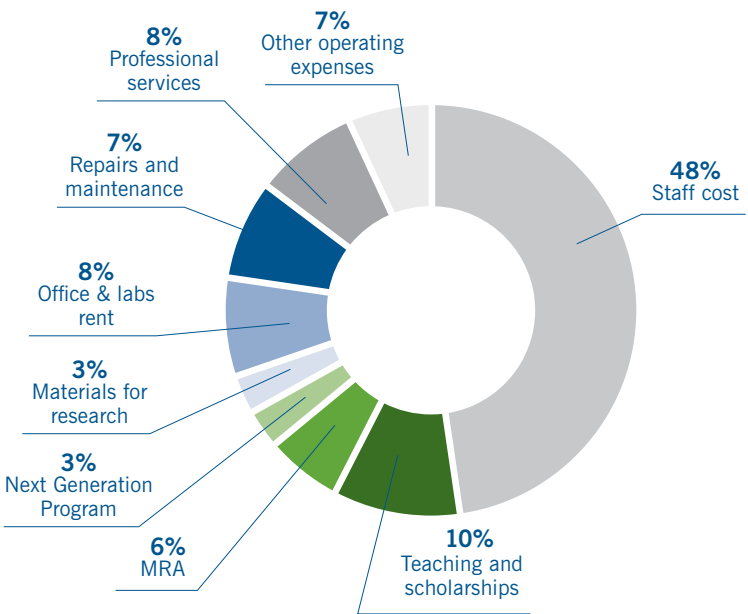


Figure 46. Institute's operating expenses

In 2017, staff costs increased by 460.8 mln RUB, or 31% as compared to 2016, due mainly to the recruitment of academic staff (24 faculty and 72 researchers), as well as to an increase in staff involved in research grants and contract activities.

Teaching and scholarships costs increased by 123.9 mln RUB in comparison to 2016 due to an increase of scholarship payments

based on the number of students enrolled.

In 2017, repairs and maintenance costs increased by 163.8 mln Rub, or 116% as compared to 2016, and included costs for the rental, design, renovation and interior fit-outs of laboratories.

In 2017, additional space for laboratories were rented due to the growing number of employees and students.

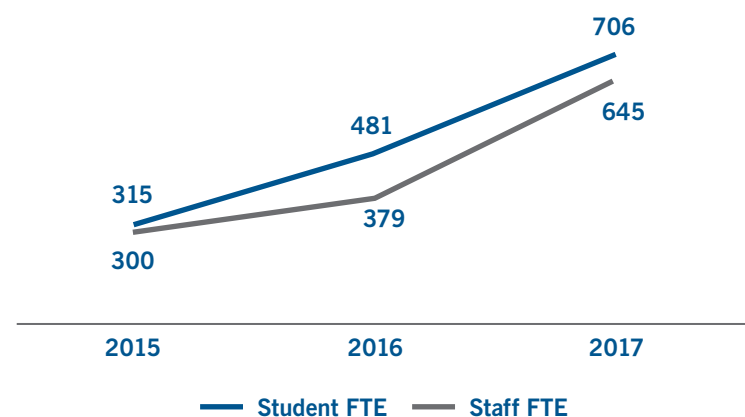


Figure 47. Students and staff 2015-2017 (FTE)

CAPITAL INVESTMENT

In accordance with the Strategic Action Plan, the Institute has committed to a long-term capital expenditure plan to assure its future sustainability, including the construction of the new Campus. In 2017, the Institute incurred capital expenditures amounting to 1

797.9 mln RUB, including 1 212 mln RUB spent on research equipment and 585.9 mln RUB on the construction of laboratories.

The Institute spent 1 016 mln RUB on the construction of training and laboratory facilities in the new Campus in 2016-2017.

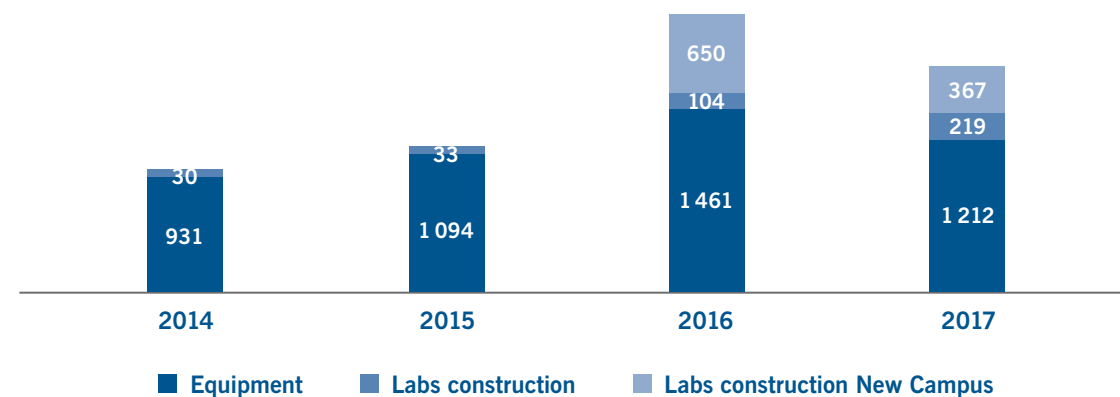


Figure 48. Institute's investments by category (mln RUB)

ENDOWMENT

The Endowment Fund has a long-term endowment strategy designed to enhance the Institute's financial independence and support the implementation of its strategy. The primary goal of the Endowment Fund investment policy is to ensure the reliability, liquidity, yield and diversification of investments. According to the Investment Declaration approved by the Management Board of the Endowment Foundation, investments can be made in the state bonds of the Russian Federation, Russian corporate bonds (from a specified list) and deposits in Russian Rubles in state-owned banks.

Endowment funds are managed by professional asset management companies, including:

- Management Company Alfa Capital
- Management Company VTB Capital Asset Management.

Asset Management Companies manage the Endowment Fund based on the rules stipulated in the Investment Declaration. The following assets comprise the portfolio of the Endowment Fund as of December 31, 2017:

Table 16. Portfolio of the Endowment Foundation

ASSETS	TOTAL		ALFA		VTB	
	RUB THOUSAND	%	RUB THOUSAND	%	RUB THOUSAND	%
Russian government bonds	2 138 399	45,33%	1 817 266	49,17%	321 133	31,43%
Corporate bonds	1 752 127	37,14%	1 752 127	47,41%	0,00	0,00
Deposits	699 322	14,82%	0,00	0,00	699 322	68,45%
Cash and Cash Equivalents	127 824	2,71%	126 527	3,42%	1 297	0,13%
Other receivables/payables	-414	-0,01%	-243	-0,01%	-171	-0,02%
Total	4 717 258	100,00%	3 695 677	100,00%	1 021 581	100,00%

All income generated by the Endowment Fund is distributed to the Institute for the purposes listed in Institute's Charter. In 2017, the Management Board gained approval to transfer 370 mln RUB in investment returns

The Management Board of the Endowment Fund has been approved to transfer a portion

of the annual return from investment at 2017 equal to 370 mln RUB to the Institute. The rest of the income generated by the Endowment Fund, amounting to 168 mln RUB was reinvested in the portfolio. In 2016, the amount distributed to the Institute was 303 mln RUB.

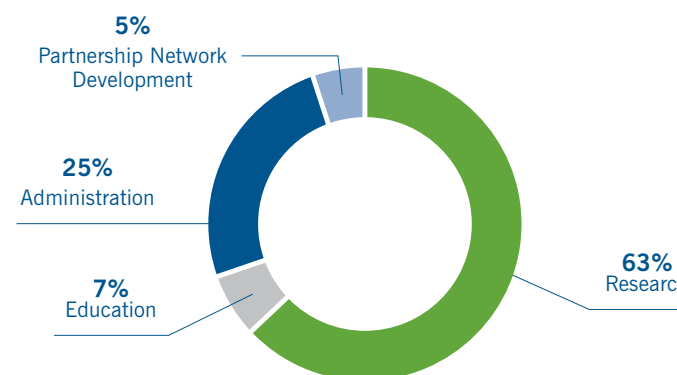


Figure 49. 2017 Endowment income distribution

The Endowment Fund’s income and expenses for 2017 included:

RUB THOUSAND	TOTAL	ALFA	VTB
Net assets as at 31 December 2016	4 556 361	3 557 538	998 823
Net assets as at 31 December 2017	4 717 258	3 695 677	1 021 581
Donations in 2017	3 719	0	3 719
Annual return from investing activities	461 047	375 627	85 420
Distribution to the Institute in 2017	303 934	237 724	66 210
Expenses for assets management services	950	865	85
Expenses for success fee	970	714	256
Financial results	461 112	375 863	85 249
Annual return in 2017, %	10,42%	10,82%	9,00%
Annual return in 2014-2016, %	9,53%	9,37%	10,10%

Notwithstanding a decrease in average market rates, the financial results from the management companies’ investment activity in 2017 is not dramatically lower than those of 2016. This is attributable to changes in the investment strategy, including an increase in the proportion of corporate and federal bonds. Also responsible were reinvestments into the Endowment Fund, as well as a shift in the income distribution schedule to the end of the year.

	2017	2016	DIFFERENCE
Annual return, RUB thousand	461 112	470 445	-9 333
Annual return, %	10,42%	11,39%	-0,97%

The Management Board of the Endowment Fund has approved for 2018 a set of measures aimed at increasing annual returns:

- To increase the duration of bonds in the portfolio from three to five years

- To increase the share of corporate bonds

In addition, the Endowment Fund Management Board considers the opportunities of investing in short-term strategies in corporate shares and real estate resulting from market analysis.

