Skoltech

Skolkovo Institute of Science and Technology

SKOLKOVO INSTITUTE OF SCIENCE AND TECHNOLOGY

INDUSTRIAL PROJECTS

2019

www.skoltech.ru/en

ALEXANDER KULESHOV

Member of the Russian Academy of Sciences, President of Skolkovo Institute of Science and Technology

We are a fully operational international university, seeking to attract talent by offering permanent employment to professionals with years of experience with the world's leading universities and high-tech companies. We have established multidisciplinary teams to address the challenges on the global science and technology agenda, such as artificial intelligence, life sciences and health, agrotechnology, photonics and quantum materials, cutting-edge engineering, and advanced materials.

Contents

ALEXEY PONOMAREV

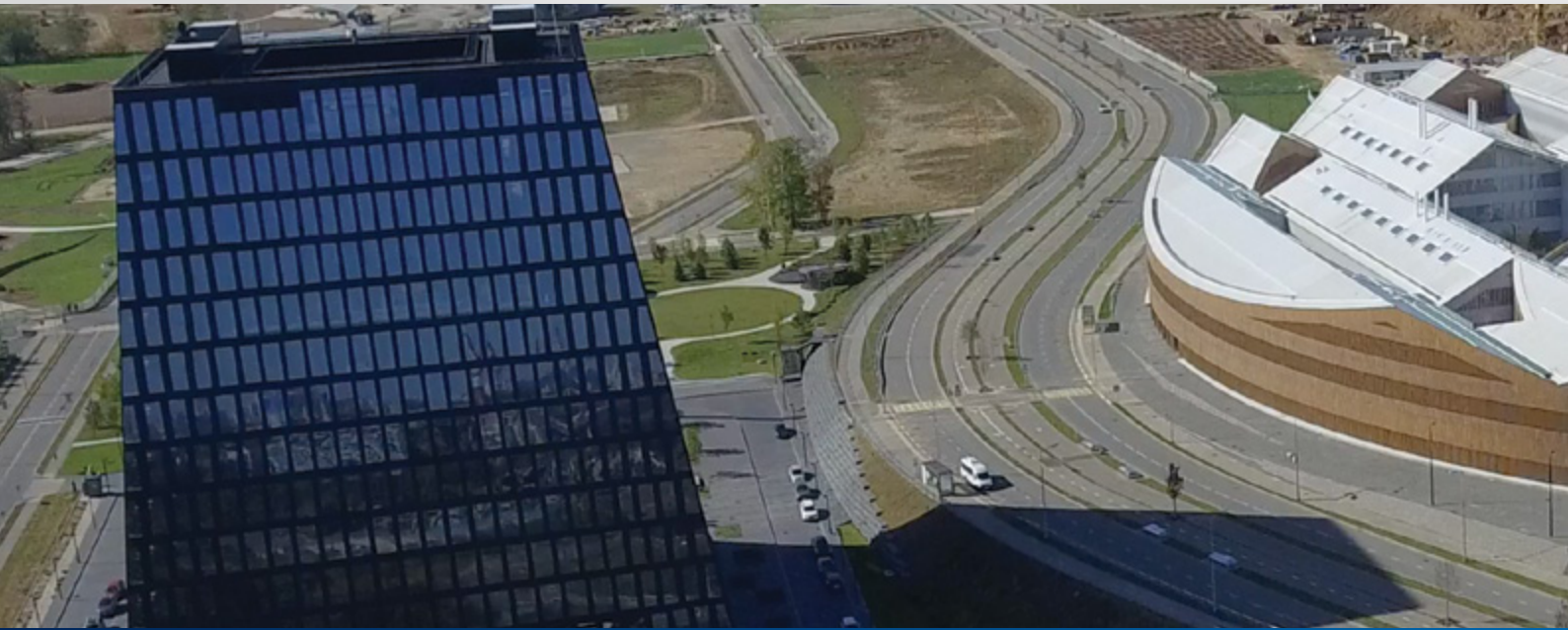
Vice President for Industrial Cooperation

Skoltech is Russia's flagship university, and alongside educating students, its mission is to create an innovation driven environment that integrates research and education, covering a broad spectrum of academic, engineering, and innovative areas. Our aim is to make the multidisciplinary discoveries needed for breakthrough technological development in Russia, and to lay the foundations of an international-level research university that will attract, educate, and hold onto gifted scholars in Russia.

Today, we believe it is vital to integrate science and industry, and to bring advanced developments to the market as fast as possible. Skoltech has all the necessary tools to achieve this. Skoltech professors and researchers, many of whom are world-class scientists, work in close cooperation with Russian and foreign research institutions and, most importantly, with industrial companies. They are also proactively involved in various different programs that are at the cutting edge of numerous innovative fields.

Skoltech is currently one of Russia's leading institutions in fields such as artificial intelligence, photonics, biotechnology, computer-aided material design, and many others.

Although Skoltech has only been around for a relatively short time, the university already has some impressive accomplishments to its name, and we definitely hope that this is just the beginning.



SKOLKOVO INSTITUTE OF SCIENCE AND TECHNOLOGY (SKOLTECH)

Established in 2011 with support from the Massachussetts Institute of Technology (MIT), Skoltech is a new internationally competitive university. The Skoltech model aims to integrate education and both academic and applied research. The Institute is fully integrated in the industrial and business ecosystem, making it possible to promote high-quality research that generates a stream of innovations entering the economy.

Work at the Institute is based on the best Russian and international academic practices, focusing on business and innovation.

In 2018, Skoltech moved onto a new campus on the grounds of the Skolkovo Innovation Center, which is a unique architectural complex designed by Herzog & de Meuron Architects (Switzerland). Skoltech's multidisciplinary approach is even visible in the architecture: research centers and labs will not operate in isolation from each other. They will instead function as an integrated complex, cooperating and communicating with each other on an ongoing basis.

SKOLTECH TODAY:

- Over 1000 full-time employees, including over 130 professors, over 200 postdocs

SKOLTECH'S MISSION:

- To attract experts in technology from all over the world to come to Russia and share that expertise with Russian companies and universities
- To maintain a balance between a broad spectrum of academic research and applied studies to benefit Russian companies

INDUSTRIAL COOPERATION:

- Research and development (R&D)
- Staff training for industry
- Support in bringing more new technology to industry
- Analytics

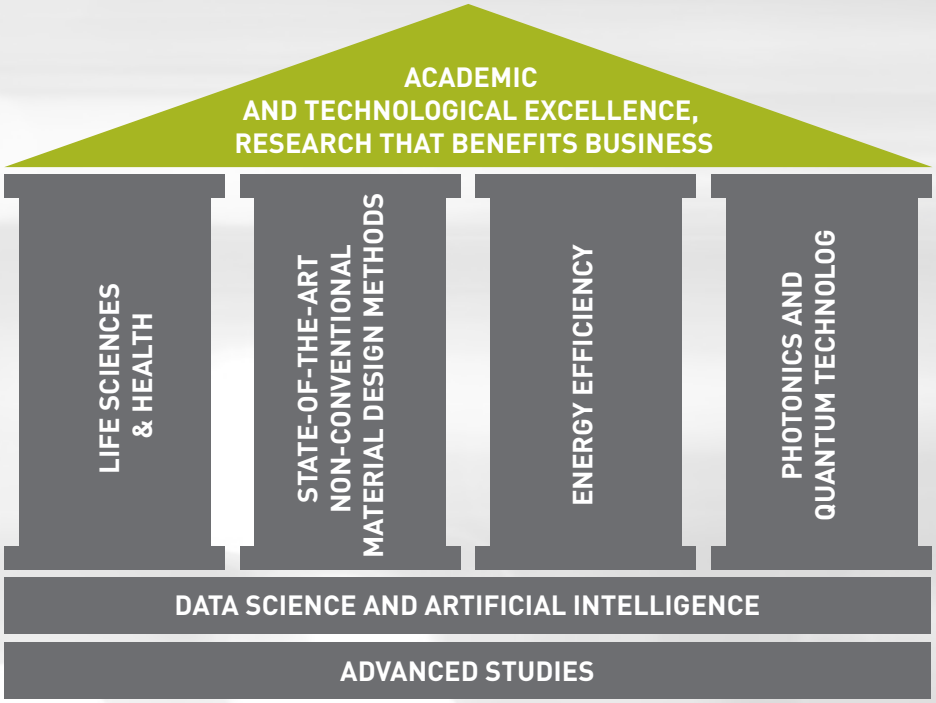
Skoltech was established as part of the Skolkovo ecosystem, which brings together Russian and international researchers and business partners, and delivers top-class infrastructure. Skoltech supports this ecosystem by promoting high-quality research, addressing issues in research and technological problems, and by generating a stream of innovations flowing into the Russian economy.

SKOLTECH AS PART OF THE SKOLKOVO ECOSYSTEM

Based on Skoltech's newly revised development strategy approved by the Board of Trustees, the third development stage for 2018–2020 will **see 6 priority areas created,** which factor in technological development priorities and expertise available at Skoltech:

- Data science and artificial intelligence
- Life and health sciences
- State-of-the-art design methods and the use of non-conventional materials
- Energy efficiency
- Photonics and quantum technology
- Advanced studies.

SKOLTECH PRIORITY DEVELOPMENT AREAS



INDUSTRIAL COOPERATION

Skoltech's Industrial Advisory Groups allow companies to take advantage of Skoltech's innovation, academic, and technological resources. The department for industrial projects helps companies establish effective partnerships with Skoltech, which may involve working together on joint applied research. In addition, specialists from different units organize industrial workshops and conferences, offer advice for companies interested in joint research and development opportunities, and facilitate the transfer of knowledge and know-how to companies.

Today, Skoltech's units work together with over 50 Russian and international companies.

THE UNITS MANAGE:

- Joint research and development activities to benefit companies, with co-funding provided by Skoltech in the most promising areas.
- Use of funding support tools for joint industrial programs, such as the Russian Ministry of Science and Higher Education, the NTI (Russia's National Technology Initiative), etc.
- Transfer of knowledge and know-how to companies.
- Applied R&D workshops and conferences at Skoltech.
- The establishment of joint ventures to bring technology to the market – infrastructure provided by the Skolkovo Innovation Center.
- Patent protection and technology licensing.
- Continuing professional education (CPE) and staff training.
- Analytics.

SKOLTECH TODAY: CENTERS FOR RESEARCH, EDUCATION AND INNOVATION

CENTER FOR COMPUTATIONAL AND DATA-INTENSIVE SCIENCE AND ENGINEERING (CDISE)

- Artificial intelligence and big data
- Machine learning
- Computer vision
- Internet of Things, etc.

CENTER FOR DESIGN, MANUFACTURING AND MATERIALS (CDMM)

- Composite materials
- PLM and digital twins
- Additive technology
- Design and preparation of digital high-tech manufacturing

CENTER FOR HYDROCARBON RECOVERY (CHR)

- Hard-to-recover hydrocarbons
- Unconventional production
- Depleted fields
- Tight oil
- Shale oil, heavy oil
- Gas condensate field

CENTER OF LIFE SCIENCES (CLS)

- Bioinformatics
- Genome editing
- Bioactive natural products
- Biomedicine
- Agritech

Skol
Skolkovo Institute of S

CENTER FOR ADVANCED STUDIES (CAS)

- A broad spectrum of areas in modern mathematics, including topology, algebraic geometry, etc.

DIGITAL FARMING LAB

- Crop farming
- Animal breeding
- Applications of digital technology in farming

tech
cience and Technology

SKOLTECH SPACE CENTER (SSC)

- Remote space sensors
- Robotics
- Space instrumentation
- System engineering
- Geolocation and space navigation
- Geoinformation platforms

CENTER FOR PHOTONICS AND QUANTUM MATERIALS (CPQM)

- Components of telecommunications and microelectronic systems based on new-generation silicon microwave radiophotonics
- Information transmission protection
- Navigation
- Communication systems

CENTER FOR ENERGY SCIENCE AND TECHNOLOGY (CEST)

- Electrochemical energy storage, energy conversion
- Smart grids
- Fuel cells
- Batteries, electrochemistry
- Computer-aided material design

CENTER FOR NEUROBIOLOGY AND BRAIN RESTORATION (CNBR)

- Brain restoration
- Developmental cognitive neuroscience
- Computational and molecular neuroscience

CENTER FOR OPEN LEARNING (COL)

- Development and replication of modern pre-university educational practices
- Development of distance continuing professional education programs

SHARED FACILITIES OFFICES (SFO)

- Genomics Core Facility
- Advanced Imaging Core Facility
- Micro- and Nanofabrication Cleanroom Facility
- Bio- Imaging and Spectroscopy Core Facility
- FabLab and Machine Shop Shared Facility
- Data Processing and Storage Cluster
- Advanced Mass Spectrometry Facility

RUSSIAN AND INTERNATIONAL PARTNER UNIVERSITIES

УНИВЕРСИТЕТ ИТМО

UNIL | Université de Lausanne

Berkeley

UNIVERSITY OF CAMBRIDGE

МИЭТ

Мичуринский ГАУ

Scottish Universities Physics Alliance

ГУАП

Санкт-Петербургский государственный университет аэрокосмического приборостроения

Stony Brook University

UNIVERSITY OF CALGARY

Novosibirsk State University

*THE REAL SCIENCE

OHIO UNIVERSITY

Fraunhofer

ISP RAS

UNIVERSITY OF TORONTO

TUM

Technische Universität München

ПОЛИТЕХ

МФТИ

ТУСУР | TUSUR UNIVERSITY

TEL AVIV UNIVERSITY

AMERICAN FRIENDS

University of Antwerp

НАЦИОНАЛЬНЫЙ ИССЛЕДОВАТЕЛЬСКИЙ ЦЕНТР "КУРЧАТОВСКИЙ ИНСТИТУТ"

University of Strathclyde Glasgow

TECHNISCHE UNIVERSITÄT DRESDEN

HERIOT WATT UNIVERSITY

JÜLICH

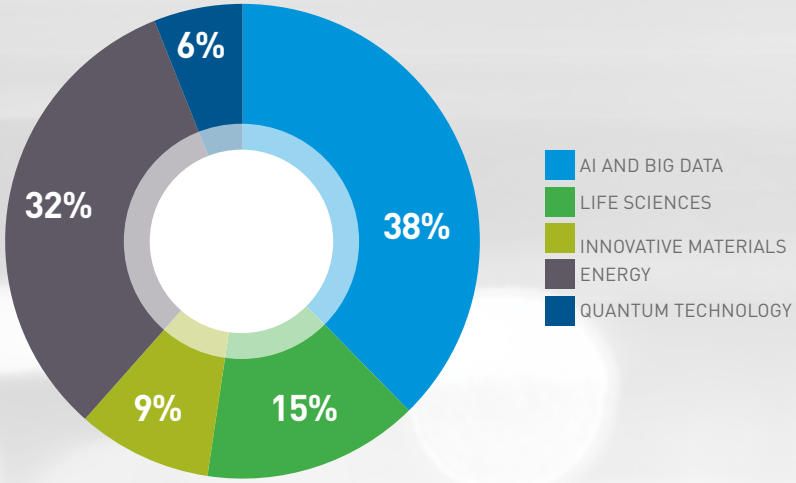
CLIENTS


HUAWEI
VisionLabs
СБЕРБАНК
AstraZeneca
РОСАТОМ
НПО ПМ МКБ
СОЮЗСНАБ
МРСК УРАЛА
BOSCH
AIRBUS
DAMATE
Северсталь
ЗАРУБЕЖНЕФТЬ
S7 Airlines
РОССЕТИ
RESHETNEV
ЛУКОЙЛ
НОВАТЭК
Концерн РТИ Системы
BIOCAD
Generium
МИРАТОРГ
ГАЗПРОМ НЕФТЬ
Schlumberger
АГРОПЛАЗМА
ТЕХНОЛОГИИ
РКС
РОСНЕФТЬ
СОКА
OAK
LG
PHILIP MORRIS
акадо
Yandex
РУСАГРО
TOTAL
PHILIPS
IBM
СНСЗ
Alibaba Group
zyfra
GEOSCAN
oerlikon
ABBYY
RUSTOR

CONTRACT AMOUNTS, 2018 (RUB MLN)

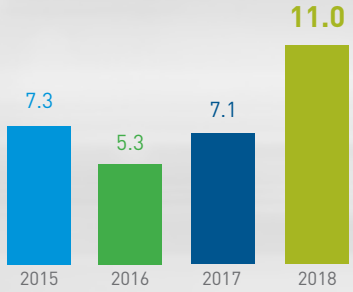
1.1 RUB BLN

PROJECTS BY AREA, 2018



FUNDING FOR INDUSTRIAL PROJECTS (CONTRACTED FUNDS) (RUB MLN)

FUNDING FOR INDUSTRIAL PROJECTS PER FACULTY (AVERAGE FIGURE) (RUB MLN)



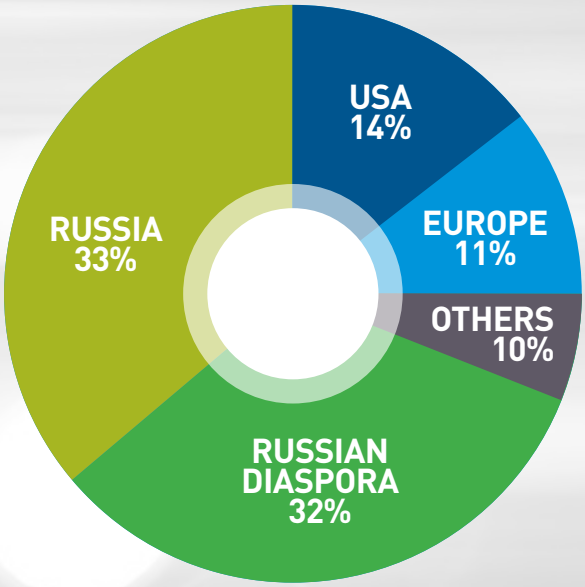
NUMBER OF PROJECTS IN 2018

In 2018, private and state-owned industrial companies implemented 118 projects

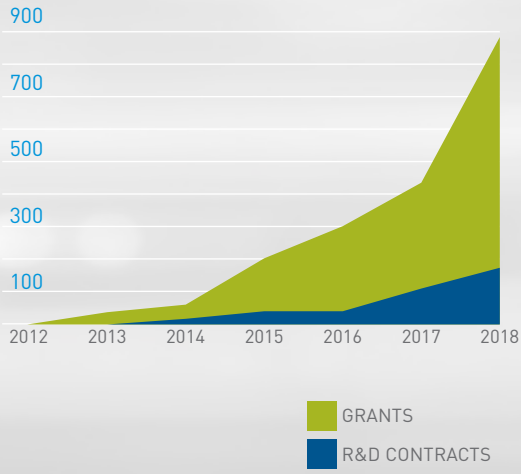
62 SHORT-TERM PROJECTS

56 LONG-TERM PROJECTS

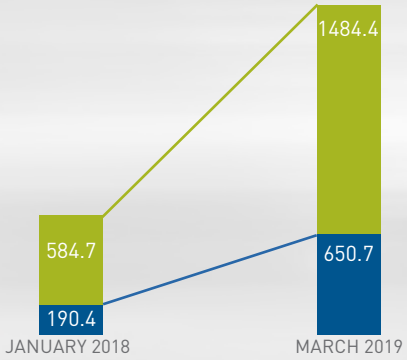
FACULTY



ANNUAL FINANCING (RUB MLN)



PORTFOLIO OF PROJECTS (RUB MLN) (CONTRACTED 2019–2022)

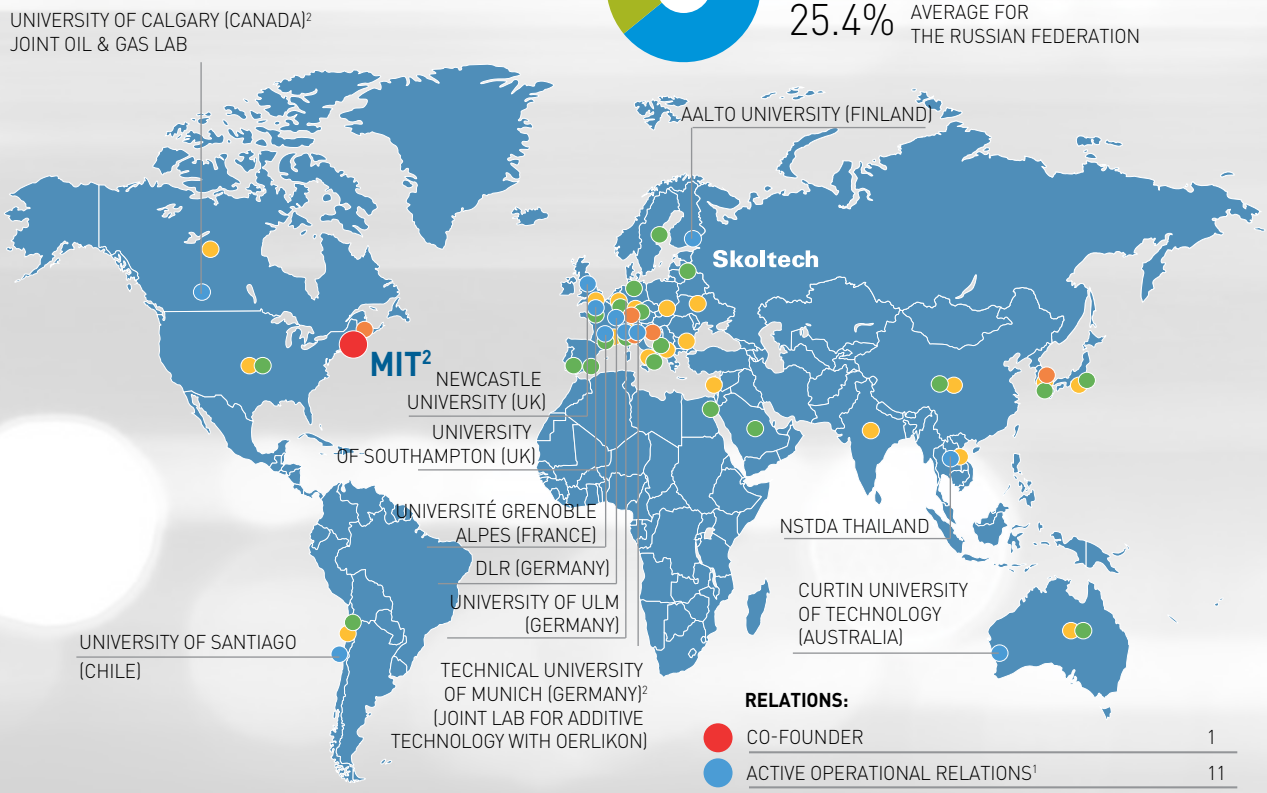


SKOLTECH'S INTERNATIONAL PARTNERSHIPS

PUBLICATIONS CO-AUTHORED WITH FOREIGN INSTITUTIONS

61.3% SKOLKOVO INSTITUTE OF SCIENCE AND TECHNOLOGY

25.4% AVERAGE FOR THE RUSSIAN FEDERATION

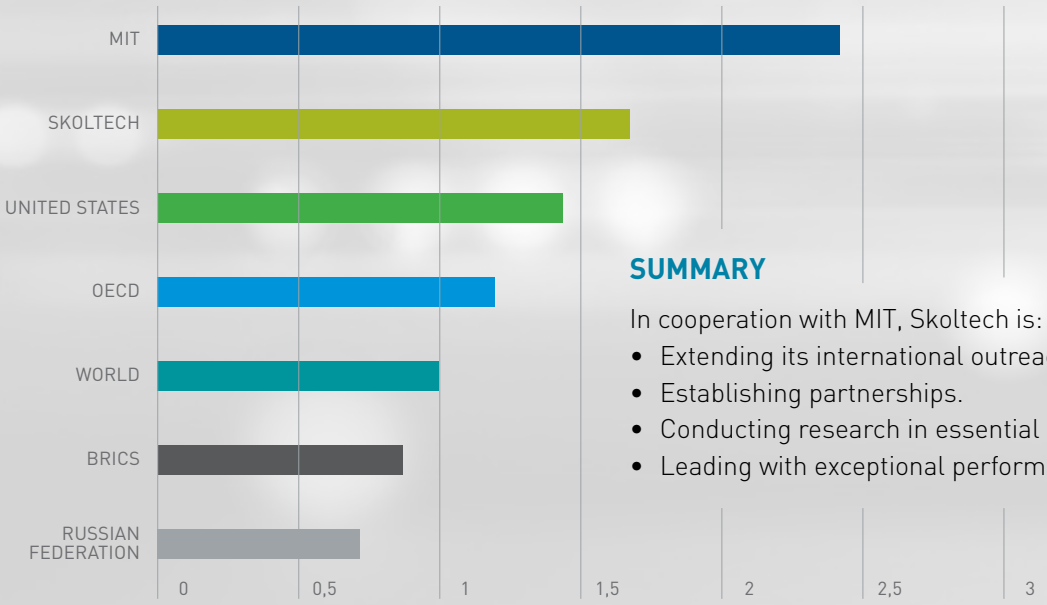


RELATIONS:

CO-FOUNDER	1
ACTIVE OPERATIONAL RELATIONS[1]	11
MEMORANDA OF UNDERSTANDING (MOU)	36
CONTRACTS	69
DESIRED RELATIONS	

1. Contract, research, exchange, Mutual Recognition Agreement (MRA)
2. Strategic relations shaped by vast experience of joint investments and labs, R&D, global industrial partners, gateway to other institutions Source: Skoltech

CITATION RATE[1]: 2013–2018



SUMMARY

In cooperation with MIT, Skoltech is:

- Extending its international outreach.
- Establishing partnerships.
- Conducting research in essential fields.
- Leading with exceptional performance.

1. FWCI: Field-weighted citation impact. Sources: Skoltech, Elsevier Research Intelligence 2018

>2,000

OF JOINT PUBLICATIONS WITH

800

FOREIGN UNIVERSITIES AND RESEARCH CENTERS FOR 4 YEARS

COOPERATION BETWEEN SCIENCE AND INDUSTRY

JOINT PUBLICATIONS WITH COMPANIES

4.8% SKOLKOVO INSTITUTE OF SCIENCE AND TECHNOLOGY

1.3% RUSSIAN AVERAGE

6.8% MASSACHUSETTS INSTITUTE OF TECHNOLOGY

3.4% UNITED STATES AVERAGE

1.9% WORLD AVERAGE

CENTERS FOR RESEARCH, EDUCATION AND INNOVATION

CENTER FOR COMPUTATIONAL AND DATA-INTENSIVE SCIENCE AND ENGINEERING

This is Skoltech's largest center engaged in start-to-finish interdisciplinary research. The center's efficient infrastructure is geared towards research and technological development. The professors at the center participate in major conferences on machine learning, most notably NIPS, AISTATS, ICML, etc., and publish papers in leading scientific journals, including Nature, the Journal of Machine Learning Research, and the SIAM Journal on Scientific Computing.

THE CENTER CONDUCTS RESEARCH IN THE FOLLOWING FIELDS:

- Artificial Intelligence, Machine Learning and Big Data, which involves the study of fast-track identification technologies for changes in big data flows, predictive analytics, computer vision and image processing, as well as recommender systems
- Mathematical modelling (MM): surrogate modelling, modelling of complex engineering and natural systems, tensor calculus, etc.
- High-performance computing/data mining
- Wireless technologies and Internet of Things dealt with by the NTI Center of Excellence in Wireless Technologies and Internet of Things, which forms a part of the CDISE

CDISE

Center for Data-Intensive Science and Engineering

MAXIM FEDOROV

Director, Professor

THE CENTER EMPLOYS OVER 140 PEOPLE:

- **23 professors**
- **Over 80 researchers**

Other Skoltech centers often draw on the expertise of professors and researchers working at the CDISE in interdisciplinary research.

ACADEMIC PARTNERS:

MIT, Berkeley, New York University, Ohio University, The University of Texas at Austin, Technische Universität Dresden

CLIENTS:

Schlumberger, Huawei, Bosch, Gazprom, Airbus, Sberbank, Alibaba Group, Yandex, Philips, VisionLabs, LG

CENTER FOR HYDROCARBON RECOVERY

The center was established in 2014. Its primary objective is to ensure the provision of world-class quality educational programs, research and innovation projects to explore and produce unconventional and hard-to-recover hydrocarbons. The center's research facilities include computer and testing labs devoted to studies in petrophysics, geochemistry, geomechanics, enhanced oil recovery methods, and gas hydrates. The center is active in developing cooperation with industrial partners. The center generates a large proportion of its budget through industrial partnerships.

RESEARCH AND DEVELOPMENT AREAS:

- Enhanced oil recovery techniques (chemical, gas, thermal injection and combined methods)
- Experimental geomechanics and geomechanical modelling
- Exploration and production of unconventional (shale) hydrocarbons
- Gas hydrates and permafrost
- Hydrodynamic modelling, multiphase hydrodynamics
- Geophysical data interpretation
- Machine learning, data mining in the oil & gas industry

SCHR

Skoltech Center for Hydrocarbon Recovery

MIKHAIL SPASENNYKH
Director,
Professor

THE CENTER EMPLOYS OVER 50 PEOPLE:

- **13 professors**
- **over 20 researchers**

HARD-TO-RECOVER AND UNCONVENTIONAL HYDROCARBONS:

- Depleted fields
- Tight oil
- Carbonate reservoirs
- Shale oil
- High viscosity-index oil
- Gas hydrates
- Polar and Arctic Shelf deposits

ACADEMIC PARTNERS:

University of Calgary
Heriot Watt
Universitetet i Stavanger
Unil | Université de Lausanne

CLIENTS:

НОВАТЭК
IBM
РИТЭК
Мессояха нефтегаз
Газпром
Роснефть
Chevron
Tatneft
Зарубежнефть
ЛУКОЙЛ
Газпром
Башнефть

CENTER FOR DESIGN, MANUFACTURING AND INNOVATIVE MATERIALS

Ever since the center was set up in 2015, its work has focused on fundamental and applied research geared towards developing and implementing innovative engineering and manufacturing concepts, to create state-of- the-art, lightweight, reliable materials and structures with an extended life cycle, for which there is a great demand across a wide range of industries.

KEY RESEARCH AND DEVELOPMENT AREAS:

- Composite manufacturing and modelling
- PLM (product life cycle management)
- Digital twins
- Additive technology
- Micro- and nanomechanics
- Coating techniques (evaporation, cold spraying, gas spraying)

THE CENTER HAS 6 MAIN RESEARCH LABS:

- Composite Materials and Structures Laboratory
- Additive Manufacturing Laboratory
- Mechanical Testing and Materials Laboratory
- Laboratory for Cyber-Physical Systems
- Micro- and Nanomechanics Laboratory
- Thermal Spray Laboratory

CDMM

Center for Design, Manufacturing and Materials

ISKANDER AKHATOV

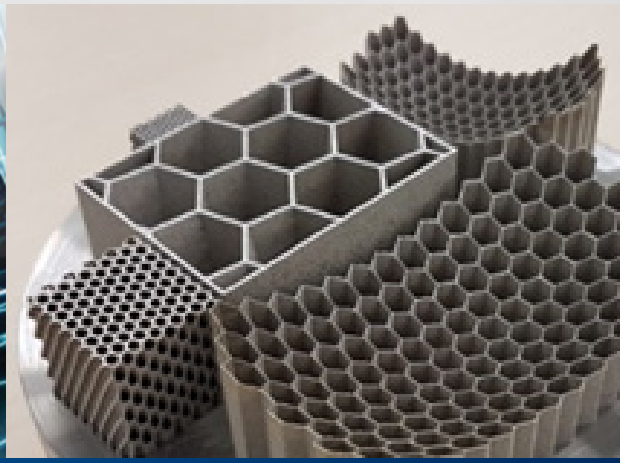
Director, Professor

THE CENTER EMPLOYS OVER 40 PEOPLE:

- 7 professors
- over 10 researchers

ACADEMIC PARTNERS

CLIENTS:



CENTER FOR PHOTONICS AND QUANTUM MATERIALS

Photonics covers a broad spectrum of research and engineering involving technologies light generation, image detection and transfer, as well as information detection, transfer, storage, and processing.

The center was established to carry out international-level research, run educational programs and develop innovations in the area of photonics and quantum materials, including hybrid photonics, polaritons, spintronics, plasmonics, and to help in finding solutions to practical challenges faced by the Russian photonics industry.

Skoltech offers innovative approaches in photonics that aim to address the most topical academic and real- world issues.

SKOLTECH KEY RESEARCH AREAS IN PHOTONICS:

- Photonic technologies for information transfer, recording, storage, and processing systems
- Innovative materials for photonics
- Quantum photonic technologies, including quantum communications, quantum simulators, quantum instruments and sensors
- Sensor systems based on optical-fibre sensors
- Micro- and nanotechnologies in photonics
- Innovative laser technologies
- Photonics in biology and medicine

CPQM

Skoltech Center for Photonics and Quantum Materials

FRANKO KÜPPERS

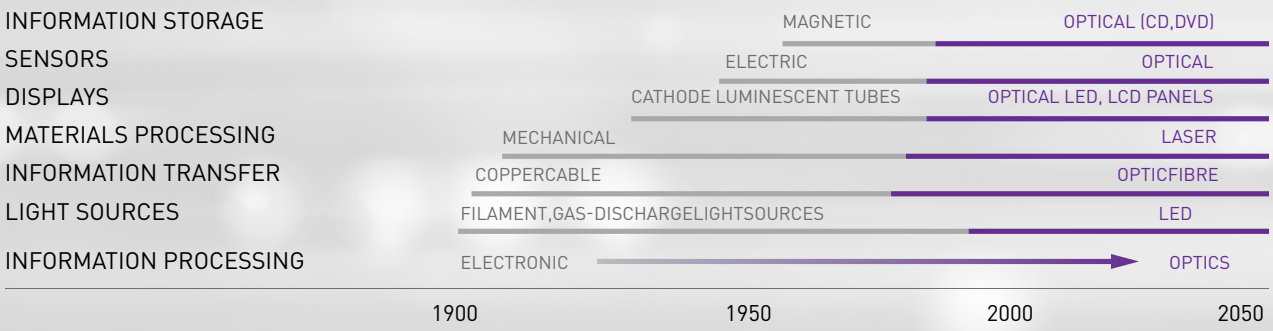
Director,
Professor

THE CENTER EMPLOYS OVER 40 PEOPLE:

- **10 professors**
- **over 20 researchers**

The systems developed at Skoltech are transforming the traditional optical signal generation, transfer, and processing methods and techniques, the technological base for heavy computing, and are also increasing the performance and dimensions of photonic and optoelectronic devices.

KEY TREND: PHOTONIC TECHNOLOGY IS REPLACING TRADITIONAL TECHNOLOGY



ACADEMIC PARTNERS:

MIT, Stony Brook University, ITMO University, University of California, Физический институт им. П.Н. Лебедева РАН

CLIENTS:

СНСЗ, РКС Российские космические системы, Концерн РТИ Системы, Седамэт Время прогнозировать!

SPACE CENTER

Established in 2013, the center's mission is to research, educate and innovate in near-Earth and cis-lunar space, with work geared towards developing innovative technologies and services to facilitate the commercial use of space and the future evolution of manned and unmanned space missions. The center proactively supports innovations by getting companies involved in developing projects and programs and by transferring knowledge and know-how.

The center's objectives include transferring knowledge and providing digital economy opportunities, problem-solving in self-contained systems, artificial intelligence and enhancing interface quality.

The center focuses on the study of innovative approaches to system concepts, and how to launch and operate complex systems throughout their life cycle.

THE CENTER'S FOUR KEY AREAS:

- Strategic thinking (how to develop and operate technology)
- Advanced engineering (space hardware and robotic systems)
- Use of complex systems (commercial use and research)
- Earth remote sensing

SSC

Skoltech Space Center

ANTON IVANOV

Director,
Professor

THE CENTER EMPLOYS OVER 20 PEOPLE:

- **6 professors**
- **7 researchers**

ROBOTICS IS NOW ONE OF THE CENTER'S PRIORITY FOCAL AREAS

The Intelligent Space Robotics Lab is a part of the Space Center that focuses on the following areas of robotics:

- Robot sensory capabilities
- Industrial robots
- Robotic components and systems for automating logistics operations
- Drones and smart sensors
- Virtual reality systems

ISR (в составе SSC)

DZMITRY TSETSERUKOU

Head of lab, professor

The Intelligent Space Robotics (ISR) Lab at the Skoltech Space Center carries out academic and applied research. It develops computer vision systems drawing on deep machine learning, and also designs navigation systems and methods for self-contained systems both outdoors and indoors (including in warehouses). The lab develops automated industrial disassembly solutions for complex systems. It is leading a plant disease detection project using multi-spectral measurements, etc.

EUROBOT – an international youth competition in engineering that serves as an informal ranking of Europe's best technical universities. It has been held annually since 1998 (by the EUROBOT Association since 2003). Over 450 teams from 30 different countries take part in the competition, and the winners gain the right to be called Europe's best engineering teams. Russia has taken part in this international competition since 2006 and has enjoyed great success.

ReSet – a team made up of Skoltech employees – secured three EUROBOT nominations in Russia and made it to Europe's TOP-5 best youth teams in 2016–2018.

ACADEMIC PARTNERS:

Massachusetts Institute of Technology

CLIENTS:

AIRBUS

PKC
РОССИЙСКИЕ КОСМИЧЕСКИЕ СИСТЕМЫ

CENTER FOR ENERGY SCIENCE AND TECHNOLOGY

The Center for Energy Science and Technology was created when two centers were merged: The Center for Electrochemical Energy Storage and the Center for Energy Systems. The integrated center conducts research in the area of energy generation and storage systems (solar cells, metal-ion and redox flow batteries), energy transfer and distribution, and integrated energy systems. Access to experimental facilities and computational power allow the center to take a comprehensive approach to both developing innovative materials with enhanced properties and to improving energy efficiency in energy transfer and distribution processes.

THE CENTER'S KEY RESEARCH AREAS:

- Electrochemical energy storage, engineering of metal ion and redox flow battery materials and cells
- Electrochemical energy conversion (water oxidation and oxygen reduction)
- Renewable energy, development of the next generation of solar energy conversion systems (Perovskite solar cells)
- Modelling processes and materials in the energy industry
- Intelligent energy systems (including Smart Grids)

CEST

Center for Energy Science and Technology

ARTEM ABAKUMOV

Director, Professor

THE CENTER TODAY

- 20 professors
- 37 researchers

ACADEMIC PARTNERS:

Massachusetts Institute of Technology

Universiteit Antwerpen

CLIENTS:

QuintTech

LG Chem

BOSCH

РУСТОР

ROSSETI

САТУРН

CENTER OF LIFE SCIENCES

Skoltech's Center of Life Sciences is one of the most dynamic centers for research, education and innovations at the Skolkovo Institute. It was established in 2018 when the Center for System Biotechnology and Biomedicine merged with the Center for Translational Biomedicine. The center was created with the aim of applying an interdisciplinary approach to life sciences.

THE CENTER'S KEY RESEARCH AREAS:

- Bioinformatics
- Genome editing
- Microbiology and innovative antibacterial substances
- Development of innovative medicine, including medicine based on RNA interference
- Immunology
- Fluorescent proteins
- Agritech

CLS

Skoltech Center for Life Sciences

KONSTANTIN SEVERINOV

Director,
Professor

CENTER TODAY:

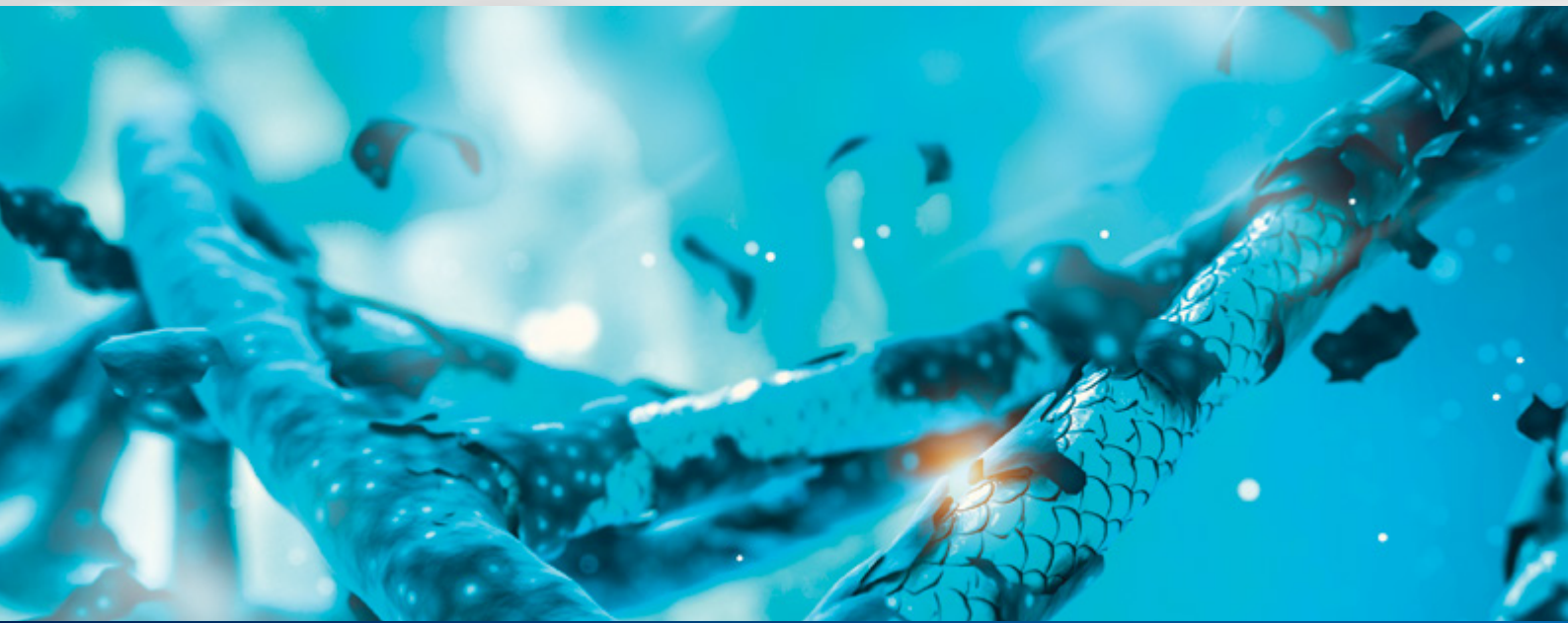
- 12 professors
- 34 researchers

ACADEMIC PARTNERS:

Massachusetts Institute of Technology
ПОЛИТЕХ
MSU

CLIENTS:

BIOCAD Biopharmaceutical Company
Generium
AstraZeneca
PHILIP MORRIS



CENTER FOR ADVANCED STUDIES

The center's strategic objective is to continue to build on the traditions of the Soviet and Russian schools of mathematics and theoretical physics, to educate the new generation of scholars by integrating education and research, creating an innovation-driven model of education, and inviting leading Russian and international scholars to get involved and contribute to the learning process.

THE CENTER'S RESEARCH ACTIVITIES PREDOMINANTLY FOCUS ON THE FOLLOWING AREAS:

- Algebraic geometry and representation theory
- String theory
- Conformal field theory, gauge theory, integrated model theory
- Combinatorics
- Symplectic geometry, topology
- Hyperbolic geometry, etc.

ACADEMIC PARTNERS:

Massachusetts Institute of Technology

The Ohio State University

University of Toronto

CAS

Skoltech Center for Advanced Studies

IGOR KRICHEVER

Director, Professor

THE CENTER EMPLOYS OVER 20 PEOPLE:

- 18 professors
- 8 researchers

CENTER FOR NEUROBIOLOGY AND BRAIN RESTORATION

Neurobiology is one of the most dynamic fields in the contemporary biosciences. Skoltech established a new dedicated interdisciplinary Center for Neurobiology and Brain Restoration in 2018, in order to develop fundamental and translational neurosciences and to learn more about how the human brain functions and its potential.

THE CENTER'S KEY RESEARCH AREAS:

- Brain restoration
- Developmental cognitive neuroscience
- Computational and molecular neuroscience

CNBR

Center for Neurobiology and Neuroreabilitation

YURI KOTELEVTSEV
Director,
Professor

COOPERATION:

MAX-PLANCK-INSTITUT FÜR AUSLÄNDISCHES ÖFFENTLICHES RECHT UND VÖLKERRECHT

ENIGMA

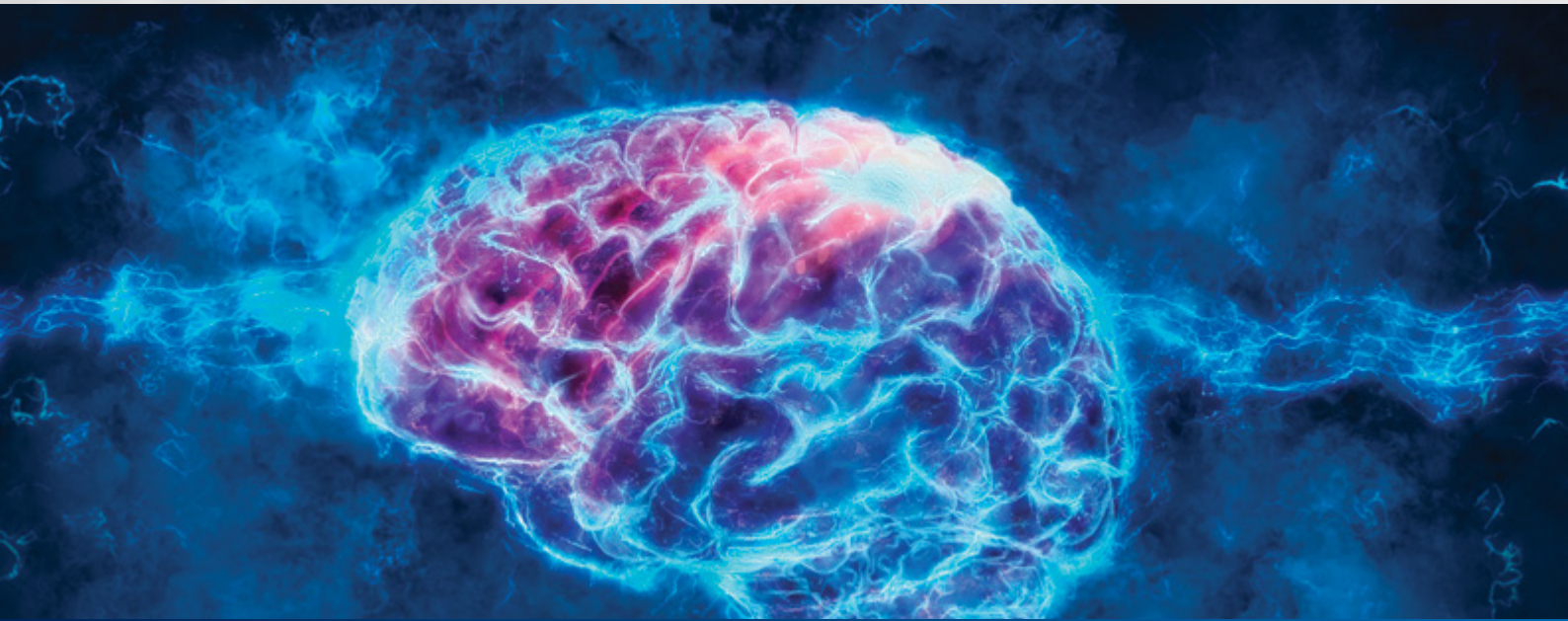
CLIENTS:

BRAINLAB

НЕЙРОНЕТ

SMARTfit

BTC
BRAIN TREATMENT CENTER



CENTER FOR OPEN LEARNING

Established in November 2018, the center's mission is to identify gifted pre-university youth and provide them with career guidance, to promote science, and to pass on the latest technological expertise through continuing professional education.

THE CENTER'S KEY RESEARCH AREAS:

- Development and replication of modern pre-university educational practices
- Development of long-distance further professional education programs

COL

Center for Open Learning

TATYANA NIKOLENKO
Director

PARTNERS:

SHARED FACILITIES OFFICES

The Skoltech Shared Facilities Offices (SFO) help achieve the Skolkovo Institute's mission in academic and applied research and the provision of educational services.

When all SFOs are up and running, they will provide a wide range of services, covering most of Skoltech's priority areas.

KEY AREAS:

- Data science and artificial intelligence
- Life and health sciences
- State-of-the-art design methods and non-conventional materials
- Energy efficiency
- Photonics and quantum technology
- Advanced studies

SFO

Shared Facilities Office

ALEXEY DENISOV

Head of Office

Setting up SFOs is a dynamic process that is based on the current and long-term needs of the Skoltech Centers for Research, Education and Innovation (CREIs) in terms of procuring research equipment and developing partnerships with academic and industrial partners.

The SFO Management Office was established as part of the Skoltech Research Department headed by the Vice President for Research (Professor Keith Stevenson), in order to coordinate the creation, efficient operation, and development of SFOs.

On February 2019, Skoltech officially had five SFOs up and running.

SFO FOR GENOMICS

The center was established in March 2018 using new-generation hi-tech equipment for high-throughput sequencing by Illumina (HiSeq4000, NextSeq, MiniSeq), hardware systems for sample preparation (Illumina cBot 2, Biomek NXp Span-8, Covaris M220, etc.), as well as the analysis and storage of retrieved data.

The center's main objective is to coordinate and support genomic studies at Skoltech and carry out research involving high-throughput sequencing for the benefit of the Skolkovo community and clients outside the Skolkovo Institute.

SFO HIGH-RESOLUTION IMAGING

The center was established in September 2018 to provide cutting-edge electronic microscopy services for both fundamental and applied studies at Skoltech and the Skolkovo ecosystem for outside customers. The center is equipped with three electronic microscopes, including a transmission electronic microscope with a monochrome electronic source and aberration correction FEI Titan Themis Z, etc.

SFO CLEAN FACILITIES FOR MICRO- AND NANOPROCESSING

The center is scheduled to launch its operations in late 2020.

The center's primary objective is to support Skoltech's hi-tech research, as well as the Skolkovo community and outside customers. The center is to be fitted out with hi-tech equipment that will be operated by a team of competent professionals, making it possible to carry out R&D activities in modern silicon photonics, 2D processing, and microwave quantum coherent circuits.

SFO BIOIMAGING AND SPECTROSCOPY

The center was established in September 2018 and is equipped with ultra-modern technology for imaging and spectroscopy at three different levels: nano-, micro- and macroscopic.

The center's main objective is to use state-of-the-art imaging and spectroscopy methods to solve interdisciplinary problems where different fields overlap — materials science, photonics, electronics, and biomedicine — in order to benefit Skoltech, the Skolkovo community, and the wider community outside Skolkovo.

SFO FABLAB AND MACHINE SHOP

The center was established in October 2018, based at the student workshop, in order to support Skoltech's educational, research, and industrial programs, the Skolkovo community, and clients outside the Skolkovo Institute. The SFO is equipped with a wide range of equipment, tools, and process lines to manufacture, analyse, repair, and modify a wide range of materials, parts, and components.

The center's key objectives include providing support for individual projects, launching start-up incubators to design products and initiate successful business projects, education based on "design – prototype – testing" models, and providing production services.

SFO DATA PROCESSING AND STORAGE

The center was created in July 2019 on the basis of the high-performance Arkuda (Lenovo) platform and data storage system with parallel files. The main objective of the center is to provide computational resources for scientific research to the laboratories of Skoltech's CREIs, external academic and industrial partners, as well as providing computing resources for the educational and innovative activities of the Institute.The center provides support to users regarding the use of supercom-computer resources, resource-intensive software, as well as computational processes of data processing, analysis and visualization.

SFO ADVANCED MASS SPECTROMETRY

Established in March 2019, the center's main objective is to provide a wide range of services in the field of mass spectrometric studies. The center is equipped with many instruments (Bruker maXis impact, Bruker timsTOF, Bruker rapifleX MALDI, ThermoFisher Q Exactive, etc.), allowing for the solution of most problems in the field of proteomics and metabolomics. Thanks to the presence of a laboratory for sample preparation, as well as computing resources for bioinformatics data analysis, the center is able to carry out a full experimental cycle. The center aims to provide high-quality services to internal and external customers, including domestic and international pharmaceutical companies.

NTI PROJECTS

The Russian National Technology Initiative (NTI) is a government program which aims to support the development of the sunrise industries in Russia that may go on to form the cornerstone of the world economy within the next 20 years. Going forward, most markets will have a network structure (inheriting online approaches or using web infrastructure). New markets will focus on the individual as the end consumer, and the distance between the manufacturer and consumer will be minimized.

Nine promising markets meeting the criteria:

- Aeronet
- Autonet
- Marinet
- Neuronet
- Healthnet
- Foodnet
- Energynet
- Safenet
- Finnet

NTI TechNet

Технет
Национальная технологическая инициатива

Experimental digital certification center

- Clearance of non-conventional products made from polymeric composite materials (PCM)
- Development and introduction of a system to monitor and predict the status of PCM products throughout the life cycle
- Creation of tools to technically regulate the market for PCM shut-off valves

TIME FRAME: 2018–2021

PARTNERS:

РЖД · АВТОДОР · РОСАВТОДОР

NTI Aeronet

Creation of an open-end set of spatial data database and integrating it with a cloud-based 4D-geoinformation platform.

Purpose: to develop cloud services for remote-sensing data processing for various applications in Tatarstan (4D-GIS platform):
- Safety area monitoring
- Agricultural purposes
- Use of digital surface models, etc.

TIME FRAME: 2017–2019

PARTNERS:

Innopolis University

CoBrain–Analytics

CoBrain Analytics

The CoBrain–Analytics national research project forms a part of the NTI NeuroNet

- CoBrain–Analytics is a platform for collecting, storing, processing, and analysing data of various different types and formats.
- The purpose of the platform is to build and support a community of users aiming to create breakthrough technologies integrating neurosciences, neurology and big data, ensuring steady growth in the NeuroNet market.

TIME FRAME: 2018–2021

PARTNERS:

НИИ Нейрохирургии имени академика Н.Н. Бурденко РАМН

CENTER OF EXCELLENCE IN WIRELESS TECHNOLOGIES AND INTERNET OF THINGS (NTI COE WTIOT)

In 2018, Skoltech won a contest for the right to establish the National Technology Initiative (NTI) Center of Excellence in Wireless Technologies and Internet of Things (WTIoT). Funding will exceed a total of over 1 billion roubles.

THE CENTER'S KEY OBJECTIVES:

DMITRY LAKONTSEV

Director

- The creation of international-level technologies to develop a comprehensive WTIoT infrastructure
- The creation of infrastructure in terms of technology and information to generate a wide range of solutions for the Russian and global market
- The development of industry-specific apps by working together with industries focusing on promising markets and global competitiveness
- Training enough highly trained professionals in various WTIoT areas to ensure the sustainable and rapid development of industry technologies in Russia and to increase their scope

PROJECTS

GLOSSARY

A client is a legal entity that issues a list of requirements, conditions, objectives, and tasks for the basis of design (BoD) and project deliverables, covers its implementation costs, and is the user of the principal output.

An industrial partner is a legal entity whose resources (equipment, workforce, technologies, feedstock, materials, energy, information resources) are integrated into a research and production process intended for project implementation.

MOTORWAY RECOMMENDER SYSTEMS

CDISE

Center for Computational and Data-Intensive Science and Engineering

Ensuring road safety is one of today's strategically important priority tasks. One of the major causes of road incidents in Russia in the winter time is icy roads. In order to ensure road safety, you need to have timely and accurate predictions to know when road surfaces are likely to deteriorate. One possible solution to this problem could be to develop new-generation information systems intended to forecast the parameters and evaluate the quality of road surfaces based on artificial neural networks (ANN). At the same time, monitoring could be managed through a distributed network of automatic sensors, which communicate the data to an integrated control center.

EFFECTS OF THE SYSTEM:

- Lower road accident rates and less risks to drivers and passengers
- More efficient road maintenance in winter
- High-quality revised description of the state of road surfaces based on deep learning methods
- More accurate prediction of road surface parameters for various time horizons using modern neural network approaches

CLIENT: МИНИМАКС-94

FUNDING: Ministry of Science and Higher Education of the Russian Federation

AVIATION INDUSTRY RECOMMENDER SYSTEMS

CDISE

Center for Computational and Data-Intensive Science and Engineering

Malfunction and failure prediction (predictive maintenance) is crucial for the aviation industry. The proposed system would be able to analyse data sent by sensors from various technical facilities, detect abnormal activity in the subsystems, predict failures and malfunctions, and optimize maintenance based on these predictions.

EFFECTS OF THE TECHNOLOGY:

- Failure detection (accuracy – up to 90%)
- Lower system maintenance costs
- Lower costs associated with plane downtime due to unexpected failure (up to 34%)

PARTNER: DATADVANCE

CLIENT: LARGE RUSSIAN AIR COMPANIES (confidentially)

PATHOLOGY DETECTION IN X-RAY MEDICAL RECORDS TO IMPROVE AGNOSTIC LEARNING METHODS DURING MEDICAL IMAGE ANALYSIS

CDISE

Center for Computational and Data-Intensive Science and Engineering

Deep learning is used to successfully create high-accuracy models across a variety of fields. The task of ensuring consistent indicators generally requires deep learning based on a large amount of information. Moreover, big data alone is not sufficient for managed learning, as it requires marked data containing information on the actual state of affairs in the classes concerned. Large computer vision data arrays (e.g. ImageNet) offer big data to develop deep learning schemes that may reflect the marking and annotations without mandatory data evaluation by experts in the field. However, medical image analysis is different and requires data marking by medical experts. The primary objective of the project is to develop a tool intended to create marked medical data arrays with required markers.

OBJECTIVE:

Identifying new marking schemes that use semantic information retrieved by analyzing the text of the medical records to ensure instant learning during medical image analysis.

Initially, the tool will be used to manage X-ray data arrays.

CLIENT: PHILIPS

DIGITAL VESSEL

NTI COE WTIOT CPQM

NTI Center of Excellence in Wireless Technologies and Internet of Things

The project allows for the creation of a platform for monitoring a vessel's life cycle and operation-related processes. In order to achieve this, the vessel will be equipped with a dedicated sensor system to analyse the current condition of the hull and propulsion group, and collect and transfer information dealing with over 200 vessel parameters, including the engine control system, fuel system, navigation and communications equipment, etc., via wireless communication channels.

These facilities make it possible to improve energy efficiency and cut operating costs by 30%.

PILOT PROJECT CLIENT: СЗСЗ Средне-Невский судостроительный завод

PARTNER: ИНВЕРСИЯ СЕНСОР

DEVELOPMENT OF ALGORITHMS TO RECOGNISE NAMED ENTITIES WITH CONFIDENCE INTERVALS TO INTERPRET MEDICAL TEXTS

CDISE

Center for Computational and Data-Intensive Science and Engineering

PROJECT OBJECTIVES:

Creating a model that would be able to automatically detect pathology on a medical image. Exploring and analyzing available medical imaging datasets.

Evaluating an MIMIC-III dataset containing medical images (e.g. X-rays/MRI scans) and clinical reports prepared by doctors.

Processing medical notes made in natural languages to detect pathology-related keywords and dealing with negation and quantifying uncertainty properly.

Studying state-of-the-art marking schemes that utilize semantic information retrieved through text analysis of the medical reports to facilitate medical data analysis.

MIMIC-III is a dataset containing medical images (e.g. X-ray / MRI scans) and reports written by doctors. A course devoted to the ethical aspects of medical data processing needs to be administered as part of this project.

CLIENT: PHILIPS

CRISIS MAPPING

CDISE

Center for Computational and Data-Intensive Science and Engineering

Large-scale natural or man-made disasters always result in considerable damage and losses affecting various different aspects of life. The proposed methods make it possible to quickly and efficiently assess the damage to enable local authorities to make decisions and assist in coordinating humanitarian aid agencies' efforts.

The master framework we are proposing may be used in a variety of operating management apps when responding to natural disasters. The framework that has been developed has shown strong performance when used to assess the damage caused by forest fires in California in 2017.

The neural network learning process involved the use of open satellite observation data for 2017 covering California (United States). At a later stage, the neural network demonstrated an impressive degree of accuracy in identifying the burnt houses on the test area damaged by wildfire.

PARTNER: DigitalGlobe™

DIGITAL TRANSLATION OF MEDICAL IMAGES FROM ONE MODALITY TO ANOTHER

CDISE

Center for Computational and Data-Intensive Science and Engineering

Each medical imaging modality has its own specific use, although it is sometimes necessary to translate images from one modality to another. One current research trend is creating electron density maps from Magnetic Resonance Images (MRI). Convolutional neural networks (CNN) have great potential in terms of classifier building. This project examines the potential CNN has in image translation. It focuses on the translation of MR images to CT intensities (X-ray absorption) and on converting MR contrasts.

CLIENT: PHILIPS

REPLACEMENT OF ELECTRIC COMMUNICATION CHANNELS WITH OPTICAL COMMUNICATION CHANNELS (OPTICAL WAVEGUIDES)

CPQM

Center for Photonics and Quantum Materials

Replacing the electric cables used to transfer electric signals with optic reduces the weight of a product, increases the amount of information transferred, minimizes electromagnetic interference, and makes the information systems resistant to outside electromagnetic action. In addition, thanks to the lightweight optic fibers, the communication channels can have multiple duplicates, which significantly improves the durability of any product in the event of any physical structural damage.

In certain cases, for instance, when it is necessary to transfer a high-frequency signal to long distances (e.g. to transfer a signal of around 100GHz to a distance measured in meters), there is no alternative to optic fiber guides.

CLIENT: HUAWEI

FACIAL RECOGNITION IN REAL-LIFE CONDITIONS

CDISE

Center for Computational and Data-Intensive Science and Engineering

Facial recognition is of fundamental importance in ensuring security, providing customer service, and in online identification. This project aims to develop a system that will use a request image to find the same person's facial image provided that the request image may be distorted (e.g. due to blurring of various kinds, light-related problems).

Results:

- **A new type (architecture) of artificial neural network** making it possible to eliminate the degradation factors that are present when facial images are taken in typical conditions.
- **A new type (architecture) of artificial neural network** combining the capacity to eliminate the degradation factors and verify (recognize) faces.

CLIENT: VisionLabs MACHINES CAN SEE

OPTIMISATION OF DEEP LEARNING ALGORITHMS FOR BIOMEDICAL IMAGE SEGMENTATION

CDISE

Center for Computational and Data-Intensive Science and Engineering

An important step in the automatic analysis of medical images is organ segmentation. Up until recently, organ segmentation in biomedical images was usually carried out using techniques such as active shape models and atlas-based segmentation. Image segmentation approaches based on deep learning later emerged that are now becoming increasingly popular when dealing with natural and biomedical images. In particular, fully convolutional network (FCN) architectures are typically used to mark each pixel in an image. FCN architectures ensure impressive results in pixel marking for natural image datasets, such as the Stanford background dataset, Pascal VOC 2012 dataset, and the challenging Large-Scale Scene Understanding (LSUN). However, biomedical image segmentation still remains a challenging problem.

The objectives of the project are as follows:

- Conducting in-depth analysis of existing neural network architecture types for biomedical image semantic segmentation and evaluating their performance
- Designing innovative deep learning architectures for biomedical image segmentation and comparing them to existing architectures
- Investigating the use of generative adversarial networks to improve the current performance of image segmentation models based on deep learning

CLIENT: PHILIPS

URBAN DEVELOPMENT ANALYTICS

CDISE

Center for Computational and Data-Intensive Science and Engineering.

The app provides urban developers, trade and real estate analysts with information about housing infrastructure without any significant time input or lengthy surveys.

The building recognition and classification model that uses satellite images is offered in a demo version of the app for GeoAlert City (geoalert.io). Our service makes it possible to highlight an area of interest and subscribe for reports containing analytics and the classification of buildings in the selected area.

The service may include the following applications:

- Population density estimate
- Functional urban zoning
- Investment potential assessment of the area based on historical data
- Space-time image analysis to detect changes in the course of construction works

PARTNER: DigitalGlobe

DEVELOPMENT OF INDUSTRIAL PRODUCTION TECHNOLOGY FOR LIGHTWEIGHT PERFORATED HONEYCOMB CORE SPACECRAFT STRUCTURES MADE FROM ALUMINIUM FOIL

CDMM

Center for Design, Manufacturing, and Materials

Developers needed to complete the following tasks:

- Develop original equipment to degrease the foil, apply glue strips on the foil using the intaglio method, corrugate the foil to form honeycomb core packages with flexible cells, hexagonal in shape
- Select the equipment and configuration of the glue preparation and polymerisation, core cutting, and packaging areas
- Develop the manufacturing process for hexagonal honeycomb core packages (size: 680x420mm, number of sheets: from 450 to 1000, foil alloys: AMr2-H, AMr5-H, thickness: from 20μm to 40μm, capacity: 5T/year) and flexible honeycomb core packages (number of sheets: from 450 to 1000, foil alloy: AMr5-H, thickness: from 23μm, capacity: 1T/year)

As a result of the project, batches of flexible hexagonal honeycomb core packages were produced from aluminium foil. The hexagonal-cell honeycomb core achieved maximum hardness and are intended to be used to manufacture flat panels. The standard honeycomb core in Russia is a hexagonal-cell honeycomb core with hexagon side size measurements of 2.5, 4, 5, and 6mm.

A flexible-cell honeycomb core makes it possible to form three-curve surfaces.

PARTNER: РЕШЕТНЕВ

CLIENT: Роскосмос

INTEGRATED PRODUCT STATUS CONTROL SYSTEMS

Non-destructive control systems for the entire product life cycle are a global trend today. A sensor system intended to monitor in-service parameters collects and transmits the information to be retained for the entire after-sale service life in real time.

CPQM

Center for Photonics and Quantum Materials

This data is processed based on machine learning techniques, which ensure a high-accuracy prediction of failure for individual parts and mechanisms, making it possible to minimize both the accident rate and after-sale service and maintenance costs.

System status monitoring unambiguously identifies the consequences of structural defects and abnormal operating conditions. This sort of identification plays a crucial part in establishing the validity of claims and calculating insurance payments.

By accumulating and analyzing data throughout the product life cycle, we can obtain the necessary feedback to further improve structures and gain game-changing opportunities to remedy the defects in the structural design in a fast-track and unbiased manner.

PARTNER: Ministry of Science and Higher Education of the Russian Federation

CLIENT: Физический институт имени П.Н. Лебедева Российской академии наук (ФИАН); РКС Российские космические системы

SERIES OF EXPLORATION AND HYDROCARBON PRODUCTION TECHNOLOGY PROJECTS FOR NON-CONVENTIONAL (SHALE) RESERVOIRS

CHR
Center for Hydrocarbon Recovery

Due to the decline in oil and gas output at depleting conventional fields, non-conventional (shale) reservoirs are becoming the focus of attention for Russian and international oil and gas producers. The challenge lies in a lack of reliable productivity criteria and hydrocarbon production technologies for these sites. R&D activities in exploration and production of hard-to-recover reserves, including hydrocarbons from non-conventional reservoirs, are among key areas of work at the Skoltech Center for Hydrocarbon Recovery (SCHR). In 2014-2018, at the order of the largest Russian oil and gas companies, the SCHR implemented a number of projects aimed at detailed specification and development of exploration and production technologies for Russia's most significant oil-source formations, primarily for the Bazhenov and the Domanik Formations. The projects aimed at developing new lithological, geochemical, petrophysical, geomechanical, and geophysical methodologies for the study of non-conventional reservoirs, specifying the regional and local productivity criteria, and designing process solutions for hydrocarbon production. The implementation of these projects involved the exploration of the Bazhenov Formation in a variety of its areas, including the Salym, Krasnoleninsky, and Niznevartovsk Arches, the Frolov Megadepression, the Yelizarov Trough, the Nyurol Depression, and the northern part of the West Siberian oil and gas basin.

While implementing these projects, the center developed new methodologies and improved the existing ones for the study of non-conventional reservoirs, making it possible to identify high-potential intervals and offer process solutions for hydrocarbon production. This is based on multi-stage fracking methods, steam, high-pressure air, supercritical water, carbon dioxide injection techniques, and hybrid approaches.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

THERMAL PROFILING OF HYDROCARBON RESERVOIRS

CHR

Center for Hydrocarbon Recovery

Thermal profiling of drill-hole cores is intended to obtain data of unparalleled representativity on variations in thermal and other (in terms of petrophysical correlations) rock properties for detailed profiling of reservoirs and the creation of representative databases for basin modelling and hydrodynamic simulation. The thermophysical profiling technology developed by Skoltech (no equivalent exists) makes it possible to collect detailed data on the heterogeneity and anisotropy of reservoirs, on thermal and stress-strain rock properties, and on rock composition (profiling of organic content in oil-source rocks) with a spatial resolution of 1 mm. In addition, continuous thermophysical core profiling is used for justified core sampling intended for detailed surveys.

The activities demonstrated high efficiency in the thermophysical profiling of reservoirs at the hydrocarbon search, exploration, estimation, and development stages.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

CORE DIGITAL ANALYSIS TECHNOLOGY FOR RELIABLE PROFILING OF COMPLEX RESERVOIR ROCKS

CHR
Center for Hydrocarbon Recovery

Degradation of reserves in the oil and gas industry is stimulating interest in reservoirs with a complex void structure. Alongside intergranular porosity, such reservoirs contain fractured vuggy voids, kerogen voids, etc. The Skoltech Center for Hydrocarbon Recovery makes extensive use of innovative digital core analysis technologies to study voids in rocks. The center possesses impressive resources for multiscale research of reservoirs using X-ray computer macro- and micro-tomography, electron-ion transmission and scanning microscopy, and advanced equipment. Digital data processing is carried out on state-of-the-art HPC software. In 2014–2018, Skoltech implemented a number of projects involving core digital analysis to study rocks at the Bazhenov, Achimov, Beryozovo, and Domanik Formations, and carbonate rocks in Eastern Siberia and other sites. The implementation of these projects involved a wide range of tasks, including:

- Void structure identification to justify the reserve estimates.
- A relative permeability assessment using core digital analysis technologies.
- An examination of changes in the void produced by different types of formation stimulation.
- An examination of kerogen porosity and kerogen topology in the rock.

The findings of studies involving core digital analysis technology are used to:

- Improve technologies for localising hydrocarbons within the target interval.
- Improve methods of resource evaluation and hydrocarbon reserves estimation in target deposits.
- Optimise well completion techniques by means of natural flow and flow stimulation by fracking.
- Develop alternative stimulation methods for target deposits to ensure extra hydrocarbon production gain.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

DEVELOPING REGULATIONS AND CONDUCTING GEOMECHANICAL SURVEYS FOR HARD-TO-RECOVER RESERVES

CHR

Center for Hydrocarbon Recovery

The surveys of stress-strain, elastic, strength, and acoustic properties of cores material pulled out to the surface make it possible to obtain reliable data on the strength parameters of rocks and deposits and build a geomechanical model of the field. A reliable geomechanical model of the field helps optimise recovery at various stages from drilling to production stimulation operations and avoid emergency situations by selecting the drilling path and drilling practices, well-completion options, and the best intervals for fracking. Core surveys are required to ensure proper interpretation of the downhole geophysical surveys, e.g. calibration of acoustic well-logging findings.

Application of GOST standards and ASTM guidelines for geomechanical surveys of complex geological sites, non-conventional or hard-to-recover reserves requires the adaptation and adjustment of recommended and permissible sample dimensions, survey parameters, and approaches to interpretation of findings. R&D activities conducted in cooperation with industrial partners included the development of techniques to test the ultimate stress under curvilinear tension, uniaxial compression, volumetric compression in a single-stage and multi-stage mode involving concurrent recording of acoustic velocities for the deposits classified as hard-to-recover reserves.

Developed regulations were used to test hard-to-recover deposits of the Volga-Ural and West Siberian oil and gas provinces.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

COMPREHENSIVE SURVEYS OF FIELD GEOTHERMAL PROPERTIES USING PRODUCTION AND PARAMETRIC WELLS

CHR

Center for Hydrocarbon Recovery

Comprehensive surveys of field geothermal properties are intended to support sedimentary basin and oil & gas system modelling with data on heat flow, equilibrium differential temperatures, rock thermal properties, and spatial variations in total organic content in oil-bearing regions under study that have no match in terms of reliability.

Comprehensive surveys of field geothermal properties using production wells enable the client to improve performance at the hydrocarbon search stage by enhancing the reliability of basin modelling.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

RESERVOIR GEOCHEMISTRY TECHNOLOGIES TO SEARCH, EXPLORE, AND MONITOR HARD-TO-RECOVER OIL AND GAS DEPOSITS DEVELOPMENT

CHR
Center for Hydrocarbon Recovery

Geochemical technologies have a proven track record in the toolkit used by oil and gas companies at all stages of search, exploration, and development of conventional and non-conventional deposits. The Skoltech Center for Hydrocarbon Recovery possesses a full range of state-of-the-art equipment and techniques for geochemical surveys, including pyrolysis (HAWK resource workstation, Wildcat technology), gas chromatography – mass spectrometry (Pyro-GCGC-TOFMS, Pegasus 4D, Leco), elemental analysis (CHNS LECO analyzer), gas chromatography (over 10 Agilent chromatographs), extraction equipment, etc. Skoltech actively implements isotope mass spectrometry (carbon, hydrogen, sulphur, nitrogen, oxygen), high-resolution mass spectrometry (FTICRMS, LTQ ORBITRAP), electron-ion microscopy, IR microscopy, solid-state nuclear magnetic resonance, ICPMS and other methods. In 2014-2018, the Skoltech Center for Hydrocarbon Recovery implemented over 25 projects addressing the challenges of hydrocarbon exploration and production by geochemical methods at a variety of sites, including the fields associated with the Bazhenov, Abalaka, Tyumen, Achinsk, Golchikhin, Georgiyev, Berezyovo, Domanik, Khadum, Filippov, and other formations.

The center conducted a wide range of surveys at these sites in order to assess the maturity and oil-bearing potential of non-conventional reservoirs, to identify the single-component and multi-component energy spectra for the actuation of kerogen thermal destruction, to study the hydrocarbon genesis and travel paths (including identification of oil from different units of the Bazhenov Formation), and to address the issues of reservoir connectivity, the monitoring of multi-layer field development, the monitoring of oil production by means of thermal stimulation methods, etc.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

INVOLVEMENT IN DEVELOPMENT OF THE BAZHENOV FORMATION NON-CONVENTIONAL RESERVES USING THERMOCHEMICAL STIMULATION TECHNOLOGIES

CHR
Center for Hydrocarbon Recovery

The Bazhenov Formation deposits are characterised by ultra-low permeability, and yet contain huge hydrocarbon reserves, including oil, natural gas, and kerogen (total organic carbon content up to 30%). Skoltech is collaborating with oil and gas companies to develop thermal stimulation technologies, including heat carrier (water, steam) injection and high-pressure air injection (in-situ combustion). Thermal stimulation of the formation leads to the generation of movable kerogen hydrocarbons ensuring a major enhancement in oil recovery for oil-source (shale) rocks. Experimental modelling of thermal stimulation and in-situ combustion involved the use of unique equipment, making it possible to run the tests at pressures of up to 420 atm and temperatures of up to 1200 °C. Laboratory tests of the Bazhenov Formation rocks made it possible to optimise the process conditions for various types of thermal stimulation.

In the near future, development and implementation of these methods will ensure Russia's energy sustainability for years to come.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

DEVELOPING AND OPTIMISING CYCLIC STEAM INJECTION TECHNOLOGIES FOR HIGH-VISCOSITY OIL RECOVERY

CHR
Center for Hydrocarbon Recovery

Production of heavy oil is very important, as viscous and heavy oil accounts for a major portion of Russia's remaining reserves, particularly in the Volga-Ural region. The project involved the selection and justification of efficient high-viscosity oil recovery technologies based on laboratory research and numerical modelling. The state-of-the-art lab equipment allowed for the analysis of over 150 rock samples (about 50 metres of drill-hole cores) and field oil samples to build a representative source database for hydrodynamic modelling purposes. Sophisticated experimental research involving non-isothermal injection of the heat-carrier into the core model of the oil-bearing formation produced oil recovery factors that are as close to real-life conditions as possible.

Comprehensive surveys of field rock properties and the findings of unique steam injection experiments provided the basis for a numerical field development model and made it possible to assess the potential economic viability of this method for enhanced oil recovery. This led to the optimization of development parameters and the selection of appropriate equipment to be used at the field.

Based on unique data, the client is planning to implement pilot projects and scale up the technology.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

EXPERIMENTAL RESEARCH OF MISCIBLE DISPLACEMENT INVOLVING ASSOCIATED PETROLEUM GAS

CHR
Center for Hydrocarbon Recovery

The main oil reserves in the Volga-Ural and West Siberian provinces are currently depleted. To provide and maintain the resource base for the oil industry, the following key challenges will be addressed:

- Ensure an increased oil recovery factor at operating fields
- Develop deposits in remote areas of the country
- Design technologies for oil and gas condensate production from low-permeable reservoirs

The list of present-day options for enhancing the oil field recovery factor and expanding the range of productive formations includes innovative oil production and enhanced oil recovery technologies, including gas technologies.

The enhancement of the oil field recovery factor, oil recovery from low-permeable and complex reservoirs, and the efficient use of associated petroleum gas can be secured by replacing flooding with gas displacement. If used properly, gas stimulation makes it possible to secure full or limited oil-gas miscibility, effectively reducing or suppressing capillary forces. Gas reduces the filtration resistance of the fluids (pressure loss) and enables the use of gravity to align the displacement front.

Gas technologies both enhance the oil recovery factor and enable efficient use of the associated petroleum gas and its products.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

REAL-TIME GEOSTEERING INVOLVING CALCULATION OF WELLBORE STABILITY WHEN DRILLING IN NON-CONVENTIONAL RESERVOIRS

CHR

Center for Hydrocarbon Recovery

Modern recovery techniques allow for the successful extraction of oil and gas from non-conventional reservoirs composed of low-porosity and low-permeability clay or silica rock. The technologies of horizontal well drilling along the oil formation, which increase the oil inflow area and enhance recovery, play a crucial part in the development of such fields. An increase in the number of horizontal wells as a percentage of total drilling is among the key trends in the development of such fields. When designing these types of wells, geomechanical stress and processes in the rock mass will be considered. The high cost of such wells, especially offshore wells, requires special attention in controlling the drilling process. It is now the rule for major projects to provide the drilling process with real-time support (petrophysics, geomechanics, geosteering). Miscalculation of overburden pressure distribution may result in wellbore collapse and well loss both at the drilling and extraction stages.

The new calculation techniques for wellbore stability developed by Skoltech in partnership with GeoSteering Technologies consider the plastic properties of the rock, which broadens the applicability of models to tight non-conventional reservoirs with high clay and kerogen content. The geosteering software package developed under the project will integrate the information on the geological structure of the field and the geomechanical model of the reservoir strain-stress behavior and make it possible to calculate safe well paths in real time and minimise drilling-related risks.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

PARTNER: GeoSteering Technologies

DEVELOPING CHEMICAL ENHANCED OIL RECOVERY TECHNIQUES BASED ON COMBINED STIMULATION BY SURFACTANTS, POLYMERS, AND NANOPARTICLES

CHR

Center for Hydrocarbon Recovery

Currently, the average design oil recovery factor (efficiency factor equivalent) falls within 30% to 40%. Therefore, even by the time development of most fields is completed, more than 50% of the oil remains in the formation. The extensive development scenario related to opening and commissioning of new fields is becoming increasingly expensive every year – finding new deposits is increasingly difficult and most of them are located in areas with underdeveloped infrastructure characterized by excessive costs of construction and business support. Therefore, the idea of the enhanced efficiency of operating fields with well-developed infrastructure and already incurred costs is becoming increasingly appealing. The list of enhanced oil recovery methods includes chemical enhanced oil recovery techniques involving the injection of various chemical agents into the formation. Normally, various combinations of surfactants, polymers, and alkalis are used. In 2014-2018, the center collaborated with Russian oil and gas companies to implement a number of projects in the following areas:

- The use of surfactants for oil-source low-permeable rocks (efficiency improvement in relation to base stimulation agent up to 400%).
- The use of surfactants/polymers for hydrophobic carbonate reservoirs (selection of an efficient combination): efficiency improvement relative to base stimulation agent up to 180%.
- The testing (in order to fine-tune the formula) of new chemical agents jointly with major international and Russian chemical manufacturers.
- The selection of synergetic solutions (including nanoparticles) to enhance the performance of technologies and chemical agents: creation of a new class of combinations (during the research).
- The testing and development of new research methodologies for hydrophobic wettability to ensure targeted selection of the agent chemical composition.

The potential operational effect is an increase in recoverable reserves by up to 2 times due to 60-80% enhancement of the oil recovery factor – 50 mln tonnes of annual output. The economic effect of full-scale technology adoption: $20 bln. The economic effect of process solution optimisation: up to 10% cost reduction, i.e. $2 bln.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

MODELLING WATER-IN-OIL EMULSION FORMATION

CHR
Center for Hydrocarbon Recovery

The content and properties of fluids in the well are determined by means of devices where the dispersed phase content is established by measuring the dimensions and concentration of drops in the flow. However, there are certain threshold values for the dimensions of drops and if the dimensions fall below these values, the abovementioned devices are unable to detect them, making the measurements unreliable. If the oil contains surfactants (e.g. certain asphaltenes) preventing the coalescence of water drops in the oil flow, then the of a major portion of the drops may fall below the threshold value set for the measuring devices. The measurement error for water-in-oil content depends on the volume ratio of the drops with dimensions below the threshold value.

The purpose of the project, implemented jointly with two global oil & gas and oil field service companies, is to develop a water-in-oil emulsion formation model and use it to upgrade hydrocarbon production and transportation technologies.

The model to be created is expected to make significant improvements in the accuracy of water-in-oil ratio observations, which will enhance measurement reliability and reduce oil production and transportation costs.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

CYBER FRACKING PROJECT (RUSSIAN FRACKING SIMULATOR)

CHR
Center for Hydrocarbon Recovery

The unavailability and the simplicity of models integrated in the Western simulators are unable to respond to the process challenges of fracking with an appropriate solution. The creation of new simulation methodologies and technologies for complex physical and mechanical processes in the oil and gas industry associated with fracking (specifically: the dispersion of proppant splitters in the well during fracking, the effect of fracturing fluid viscosity on proppant position in fractures, the effect of the complex rock structure and actual fracture morphology, settling, and the transport of particles in fractures) will bring the technology to an entirely new level. This project, implemented jointly with the Russian oil and gas industry, both considers all significant existing solutions and investigates the effects having an impact on the feasibility of the fracking process that were not previously covered by simulation. The primary deliverable of the project will be the creation of a Russian fracking simulation platform and the optimization of design for complex shale wells.

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENTS: Газпром нефть

PARTNERS: ПОЛИТЕХ, МФТИ

INJECTION WELL MODELLING

CHR
Center for Hydrocarbon Recovery

One of the primary tasks of formation pressure maintenance in hydrocarbon field development is to model formation contamination in injection wells. By way of a solution, the lab suggests an analytical tool in the form of a one-dimensional three-continuum slurry filtration model to describe permeability reduction in the injection well bottom-hole area. This produces a mathematical model implemented in the source code to be used to enhance the intake capacity and clean the well bottom-hole area.

The benefit of the injection well modelling technology as compared to older technologies is the calibration and validation of the model based on core clogging lab experiments.

The modelling of slurry filtration in the vicinity of injection wells makes it possible to consider the suspended solids content effect.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

DRILLING HYDRAULICS SIMULATOR

CHR
Center for Hydrocarbon Recovery

Miscalculation of pressure distribution raises the risk of fracking technology, including the issue of well integrity and drilling safety. The development of a solution (hydraulics simulator) makes it possible to optimise and properly calculate pressure distribution along the wellbore during drilling. The study is based on an interpolation approach that in turn relies on kernel-based methods. Looking ahead, this technology facilitates the creation of decision-making support systems for mud engineers and automatic drilling control. The hydraulics simulator is capable of ensuring the maximum optimization of the drilling process and mitigating the well damage risks for engineers.

A pressure distribution prediction tool helps mitigate the risk of undesirable geomechanical phenomena during the drilling process (self-induced hydraulic fracturing, wellbore takeout).

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

META-MODELLING OF MULTIPHASE FLOWS IN WELLS AND PIPELINES

The existing cumbersome and resource-intensive approach to multiphase flow modelling, when designing the surface infrastructure and wells, does not meet the subsoil users' process requirements. The industry needs accurate, fast, and stable simulators.

CHR

Center for Hydrocarbon Recovery

The Center for Hydrocarbon Recovery offers an engineering solution (a meta-model based on lab and field data) that makes it possible to accelerate the calculation of pressure distribution in the wellbore or pipeline at different angles in a fixed configuration and increase the reliability of bottom-hole pressure calculation for the "formation-well" system. The solution is based on classification algorithms for flow pattern interpretation and on regression analysis for predicting the volume ratio of the fluid.

The meta-model to be developed expands the scope of existing solutions and enables a significant expansion of the range of classical and mechanistic correlations. The meta-model based on lab data makes it possible to accelerate the differential pressure calculation and enhance modelling accuracy.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

MACHINE LEARNING FOR FRACKING OPTIMISATION

Due to the lack of a uniform information approach to systematisation and critical analysis of fracking data, the labour input required to interpret and optimise findings results in a growing number of unsuccessful well operations.

CHR

Center for Hydrocarbon Recovery

The Center for Hydrocarbon Recovery is developing machine learning methods to optimise fracking design based on well-known methods, including the Gaussian process, Decision Trees, a Support Vector Machine, and ensemble approaches to improve the predictive analytics quality. The designers are involved in digital transformation of an oil company by offering recommendations regarding fracking data collection, storage, and analysis.

The deliverables will facilitate the oil engineers' work at the stage of field data expert review and accelerate decision-making processes when selecting the appropriate wells for fracking stimulation. This creates a protective process superiority in preparing data, evaluating fracking performance, and securing the target development indicators. Machine learning based on field data will make it possible to secure the design fracking indicators and accelerate decision-making processes when selecting the appropriate wells.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

CLEANING AND COMMISSIONING OF THE WELL FOLLOWING MULTI-STAGE FRACKING

CHR
Center for Hydrocarbon Recovery

The improper start-up of a well following the fracking operations results in fracture conductivity degradation due to a combination of factors: rock/proppant crumbling, a decline in proppant packing permeability and width, and clogging.

The designed solution involves the development of recommendations on post-fracking well cleaning based on establishing the optimum shape of the propped area in the fracture in order to maximize conductivity and minimize degradation. This task requires brand-new mathematical models of various degradation mechanisms alongside parametric calculations.

The project is intended to create brand-new detailed models to upgrade the research of effects that help minimize plastic deformation of the rock and reduce the compression and crumbling of proppant packing.

The technology developed by Skoltech helps select the optimum fracking schemes and increase the initial well flow rate.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

DEVELOPING RECOVERY TECHNOLOGIES FOR LOST CORE 3D STRUCTURE

CHR
Center for Hydrocarbon Recovery

Awareness of the rock properties at the developed field is a prerequisite for maximum oil recovery. The most reliable data on these properties can be produced by examining the cores (drill samples) and thin sections of reservoir rocks.

Due to various reasons, rock samples may be lost during storage or transportation. In a situation when the only sources of information on lost samples are the pictures of thin sections, machine learning enables the recovery of the core 3D structure.

The technology developed in cooperation with an oil and gas company makes it possible to restore the rock microstructure by means of neural networks. The resulting data may be used to calculate the geological and recoverable reserves, to pick up the optimum stimulation methods to enhance oil recovery, and to address miscellaneous tasks.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

PREDICTING THE TYPE OF DRILLED ROCK

CHR

Center for Hydrocarbon Recovery

Horizontal drilling in a severely stratified section requires ultra-high precision wellbore positioning in a thin productive zone that is very deep. Due to their design features, the sensors identifying the type of drilled rock are located far above the boring head. Therefore, deviations from the target interval are not recorded in a timely manner (in 20-40m). This leads to the loss of the productive part of the wellbore and a likelihood of over-drilling. The tool for predicting the rock type on the drilling head based on a combination of decision trees (XGBoost) and "intelligent" pre-processing makes it possible to identify the type of drilled rock using the surface measurement data.

The tool developed by Skoltech helps improve well drilling accuracy by up to 92% and reduces the risk of wellbore over-drilling.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

PREDICTING THE FRACKING EFFECT

CHR

Center for Hydrocarbon Recovery

Fracking is a process of establishing a system of fractures in the productive zone and one of the most popular enhanced oil recovery methods. However, the costs of these operations are high, and yet the efficiency of the process cannot always be predicted due to a large number of factors involved: completion system configuration, fracking design, peculiarities of wellbore geology, etc., XGBOOST-based machine learning fine-tuned for the peculiarities of the task makes it possible to:

- Analyze the data of previous works.
- Identify the most influential factors.
- Predict the expected effect.
- Pick up the optimum well/design combination for fracking operations.

This approach allows for the selection of optimum fracking schemes and increases the initial well flow rate.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

AUTOMATED PROCESSING OF WELL GEOPHYSICAL SURVEYS

CHR
Center for Hydrocarbon Recovery

Analyzing of geophysical data plays an important part in hydrocarbon prospecting. Geophysical surveys make it possible to establish oil production potential, and therefore, provide the basis for the assessment of financial return and economic benefit. Geophysical surveys make it possible to assess multiple significant parameters, including porosity, lithology, water saturation, permeability, and many other properties influencing decision-making.

Skoltech offers a technology based on intelligent data analysis that is able to:

- Reveal subtle functional ties between important properties of the formation.
- Build a geological-geophysical model.
- Detect the reservoir/non-reservoir properties.
- Restore missed intervals.

The technology identifies the most significant geophysical tools and reduces the surveying scope at the local level.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

REGIONAL MULTIDIMENSIONAL PETROPHYSICS

CHR
Center for Hydrocarbon Recovery

To build a geological model of the field, it is necessary to assess the essential filtration-volumetric parameters of the rock as accurately as possible. The technology under consideration makes it possible to build petrophysical and interpretation models automatically using the multi-criteria optimisation method. This increases the accuracy of the models and accelerates their creation. As a result, geological and hydrodynamic models of hydrocarbon deposits become more reliable. Machine learning algorithms make it possible to predict the filtration-volumetric parameters at the local level in under-investigated areas resulting in a lower scope of necessary lab research of the core.

The engineering solution makes it possible to build petrophysical models of filtration-volumetric parameters and reduce the scope of core research.

CLIENTS: LARGE OIL AND GAS COMPANIES (confidential)

INVESTIGATING THE EVOLUTION OF GAS-SATURATED TALIKS AND GENERATION PROCESSES OF THE YAMAL CRATERS WITHIN THE PERMAFROST IN THE NORTH OF WEST SIBERIA

CHR

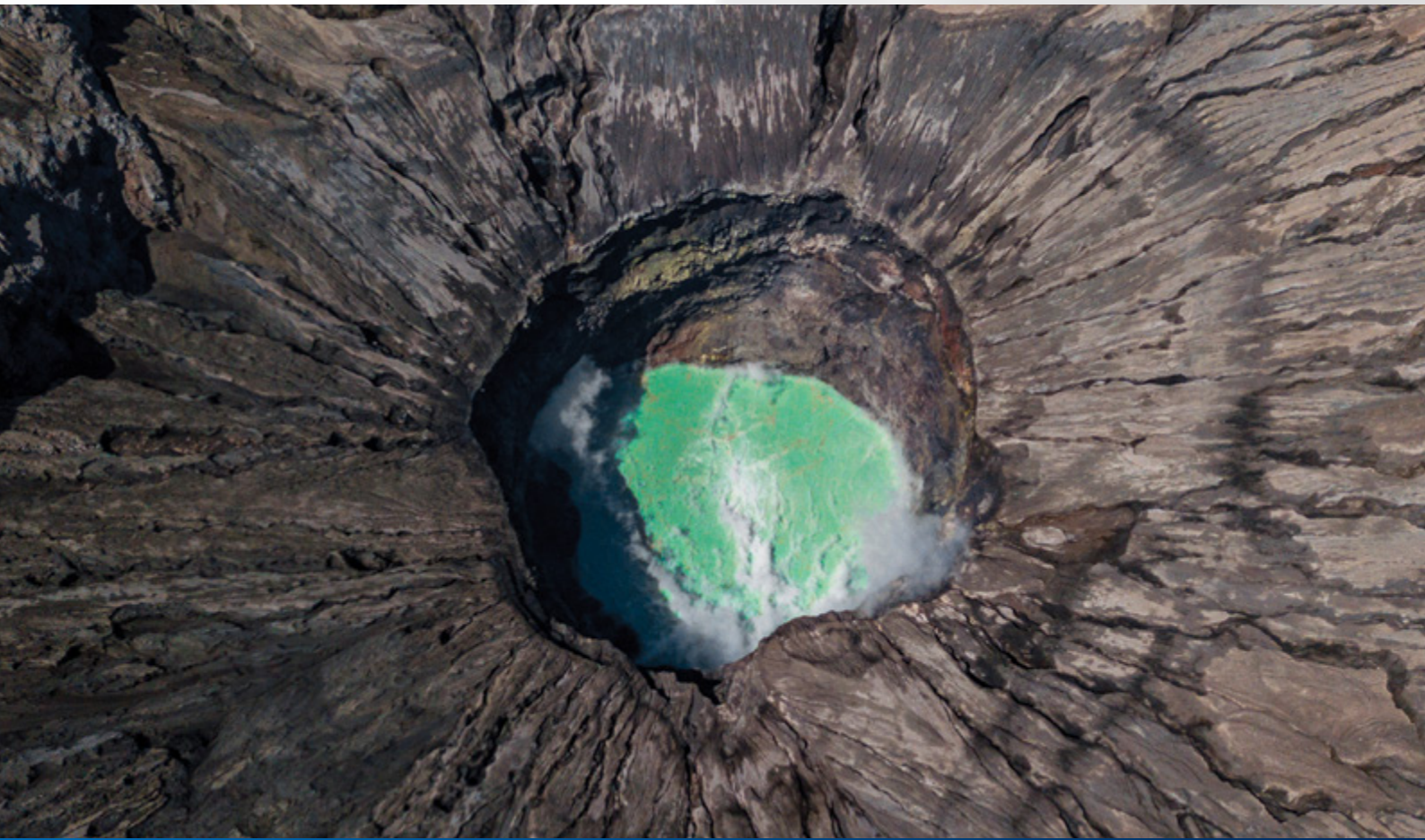
Center for Hydrocarbon Recovery

In recent years, abnormal rock outbursts from the permafrost upper layer resulting in large-diameter craters were recorded in the Arctic region of Russia. One such hole was found in June 2017 in the Yamal tundra thirty kilometres east of Yerkuta research station. A scientific expedition, which was initiated and organized by the Government of the Yamal-Nenets Autonomous District and supported by Total oil company, involving Skoltech researchers was dispatched to the Yerkuta Crater in December 2017. The expedition included field surveys of the crater and sampling of frozen rock and subsurface ice to be further examined in the lab.

The works on the project, which aimed at studying the new geological formation called the «Yamal Craters», produced formation models based on field data analysis alongside mathematical, thermodynamic, and experimental simulation. The approaches developed under the project describe the genesis and build-up of pressure in the frost-susceptible enclosed gas-saturated talik areas located in the vicinity of the daylight surface. These models are used to analyse the geological risks associated with this natural phenomenon.

CLIENT: YAMALO-NENETS AUTONOMOUS OKRUG OF THE RUSSIAN FEDERATION

PARTNER: TOTAL



PROJECT FOR THE DEVELOPMENT OF A NEW CLASS OF ULTRA-HARD MATERIALS IN THE OIL AND GAS INDUSTRY

CEST
Center for Electrochemical Energy Storage

This is a project to create innovative ultra-hard materials for drilling bit cutters. This Russian innovation will compete with imported products by lowering manufacturing costs for drilling bits by 10–30% and will provide a breakthrough for other industries – construction, mining, and instrument engineering. The first advanced prototypes of innovative ultra-hard materials have already been designed. The material will be able to replace the expensive diamond.

The introduction of innovative industrial materials will almost halve the cost of cutters using new materials and reduce the cost of drilling bits by up to 20%.

CLIENT: ГАЗПРОМ НЕФТЬ

PARTNER: Institute for High Pressure Physics Russian Academy of Sciences after Vereshagin

DIAGNOSTIC TECHNIQUE FOR OVERHEAD LINE AND SWITCHGEAR INSULATION (6–220KV) USING UV INSPECTION

CEST
Center for Electrochemical Energy Storage

The project focuses on developing a UV inspection data interpretation technique for overhead power line and switchgear insulation. Experimental research allowed values to be obtained for the insulator surface partial discharges according to different weather conditions at the inspection point, different insulator types, and other factors.

The neural network model that has been developed and the database make it possible to rank the insulators according to the likelihood of flashover, which allows the insulator in need of replacement to be identified. Product: insulator diagnostics guideline and line service electrician software.

CLIENT: МРСК УРАЛА

MONITORING OF ICE FORMATION AROUND LOCAL ELECTRIC POWER GRIDS

CEST

Center for Electrochemical Energy Storage

The project aims to develop a method to assess the parameters dealing with the formation of ice on overhead power lines based on the data from the weather forecast model, and verifying it in the operating power grids.

The project delivers a product in the form of two packages of equipment to measure the rate at which ice accumulates on the cables and meteorological data, as well as software for the person in charge of the network district.

CLIENT: Мэп Меükep

HIGH-POWER AND HIGH-CAPACITY CATHODE MATERIALS FOR LI-ION BATTERIES

CEST

Center for Electrochemical Energy Storage

The aim of this project is to develop a scalable manufacturing process for two types of cathode materials for Li-ion batteries:

a) LiFePO4 (LFP) with a quick-charge feature, which can also be used for doped Mn LFP (LFMP) with specific energy increased by 20%

b) Low capacity-loss Li(Ni,Mn,Co)O_2 (NMC), which can also be used for enriched Li NMC (Li-NMC) with specific energy increased by 30%

CLIENT: RUSTOR

COMPONENT BASE FOR SILICON MICROWAVE RADIOPHOTONICS

CPQM

Center for Photonics and Quantum Materials

Radiophotonics deals with the conversion of a radio-frequency signal into an optical signal, propagation of this signal via the waveguides, and its conversion back into the radio-frequency spectrum. Radiophotonics is important due to excessive losses associated with the transfer of microwave signals via electrical channels.

To convert a radio-frequency signal into the optical band, radio frequencies need to be generated within a certain spectral interval, and the optical signal with them needs to be modulated, which requires high-frequency electro-optic modulators. After the signal is sufficiently propagated, it is then converted from the optical back into the radio-frequency band using high-frequency detectors.

A fully optical analog-to-digital converter is widely used in other areas. This type of converter enables a switchover from analog to digital modulation with all the benefits of the latter format. The devices that come in an integrated form are particularly sought after as they are even more compact.

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENTS: Концерн РТИ Системы

PARTNERS:

DEVELOPMENT OF ACCELERATED SELECTION TECHNOLOGY FOR OIL CROPS

CLS

Center of Life Sciences

- Large-scale genotyping and molecular phenotyping of 600 sunflower samples and 100 rapeseed samples
- Identification of genome loci allele status associated with sunflower and rapeseed utility characters
- Customized DNA chip prototype

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENT: АГРОПЛАЗМА

DEVELOPING A PROTOTYPE FOR INNOVATION-DRIVEN SOY SELECTION PROGRAM

- Conducting whole genome sequencing and genotyping by sequencing (GBS) 300 soy samples
- Designing molecular markers and testing them on soy samples provided by an industrial partner

CLS
Center of Life Sciences

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENTS: ПОЛИТЕХ, СОКО семена успеха **PARTNER:** ВИР

DEVELOPMENT OF A GENETIC EVALUATION METHOD FOR PEDIGREED SWINE

- High-density microchip genotyping of 3300 pigs
- Mass spectrometry of lean and fat tissue samples
- Databases of pedigreed swine genome variability and lipid composition of fat and lean tissue
- LD panel integration in the genome evaluation of pigs

CLS
Center of Life Sciences

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENT: **PARTNER:**

CREATION OF A METHOD TO EVALUATE AND A SYSTEM TO MONITOR REGIONAL DAIRY CATTLE BREEDING IN THE REPUBLIC OF TATARSTAN

CLS
Center of Life Sciences

In order to make the dairy industry more efficient and reduce its dependence on imported breeds, full use needs to be made of modern population-genetic and genomic technologies, and the genetic resources need to be managed.

In August 2018, the Republic of Tatarstan launched a project with the aim of developing a research-backed concept for an overall pedigree stock breeding system for dairy cattle.

The project incorporates 20 breeding farms in the Republic of Tatarstan (including Parent Breeding Enterprise Elite JSC) with a total livestock of 22,000. Based on genealogical analysis and genetic diversity principles, 2000 cows were selected from a representative sample for genotyping. The project also involves genotyping for all bulls in PBE Elite JSC. When it is completed, the project will deliver an original selection index that can be used to calculate the genetic index of the pedigree stock in the region and select the stock to breed genetically improved livestock, giving a more accurate prediction of the livestock yield indices improving the milk-yield rates and other utility characteristics of the dairy cattle in the region.

The project is supported by the Irish Agriculture and Food Development Authority (Teagasc).

CLIENTS:
MINISTRY OF AGRICULTURE AND FOOD OF THE REPUBLIC OF TATARSTAN (RUSSIAN FEDERATION)

PARTNERS:

Sustainable Food Systems Ireland
A partnership of Irish Government agencies

MONITORING OF SOIL FERTILITY FACTORS AND ANALYSIS OF THE TRANSFORMATION OF ORGANIC MATTER IN THE SOIL

CLS
Center of Life Sciences

- Technologies to maintain soil fertility and enhance it: fertilizer amounts and fertilization techniques depending on field irregularities

PARTNER:

AUTOMATED DIAGNOSIS OF APPLE TREE DISEASES

- A pilot project to enable the diagnosis of a variety of apple tree diseases using a multi-spectral camera.
- In the long-term there are plans to develop an automated diagnostic system that makes use of computer vision.

CLS

Center of Life Sciences

CLIENTS:

СОЮЗСНАБ
ТОРГОВО-ПРОМЫШЛЕННАЯ ГРУППА КОМПАНИЙ

ЗЕЛЕНЫЕ ЛИНИИ

NURSESIM VIRTUAL REALITY SIMULATOR

SSC

Space Center

NurseSim Virtual Reality Simulator was developed to train hospital and health clinic staff to deliver basic patient care, including safe relocation and diagnosis of visible symptoms.

The simulator was developed in Unity 3D including a function to render an image of the physical interaction between the user and the patient visible through virtual reality headsets. In order to ensure the sensation delivers optimal movement for the user, we have developed a haptic interface that makes the simulator more realistic. In addition, to improve learning efficiency, we have introduced AI elements in the form of a reinforcement learning model, which makes NurseSim more user-friendly.

STATISTICAL ANALYSIS AND MODELLING OF BRAKING DATA FOR ELECTRIC VEHICLES

CDMM

Center for Design, Manufacturing and Materials

The number of electric cars worldwide is rising every year. The major differences of electric vehicles from ICE vehicles require the development of relevant models that consider the braking peculiarities of such vehicles. Modelling the behaviour of braking parameters throughout the life of the electric vehicle is an important task. Extrapolation models are used for that purpose. Skoltech possesses a vast practical experience in mathematical modelling.

The primary purpose of this work is to build relevant models and ensure the quantile calculations (number of incomplete breakages, maximum pressure, and pressure differential) for each individual electric vehicle.

CLIENT: BOSCH

DEVELOPING A PREDICTIVE MODEL FOR ESTABLISHING THE VEHICLE BRAKE PADS WEAR

CDMM

Center for Design, Manufacturing and Materials

The wear of brake pads depends on a large variety of factors and may be attested to by complex combinations of various parameters of the vehicle. To identify the parameters characterising the extent of wear, it is necessary to use big data methods. Skoltech possesses a vast experience in this area.

The primary purpose of this effort is to build the relevant classification model for the parameters characterising wear of brake pads. A self-learning software is supposed to use the sensor readings to ensure a classification of brake pads depending on the extent of wear. Over 100 parameters of the vehicle are recorded during each breakage at 3 ms intervals.

CLIENT: BOSCH

CLUSTERING AND CLASSIFYING ROAD DAMAGE BASED ON VEHICLE ACCELERATION TIME SERIES

CDMM

Center for Design, Manufacturing and Materials

The number of sensors inside the vehicle is increasing every year, which enhances driving autonomy and safety. 3D accelerations and LIDAR data are recorded on the move to analyse traffic conditions. Various data are used to generate orthophotos.

The primary purpose of the project is to conduct an exploratory data analysis, audit the data quality, and create a Matlab script that actuates the clustering and classification algorithm for the accelerometer data to identify road damage.

CLIENT: BOSCH

ADENO-ASSOCIATED VIRUS-TRANSPORTED NUCLEASES TO BE THE NEXT-GENERATION GENE MEDICINE FOR HEREDITARY DISEASES

CLS

Center of Life Sciences

Traditional treatments for hereditary diseases and the patient care funded by taxpayers are expensive, so a transition to individualized and prognostic medicine is therefore one of the top priorities included in the Russian Science and Technology Development Strategy.

Gene therapy of hereditary diseases is categorized as personalized medicine.

The project is intended to search for new CRISPR-Cas nucleases of max. 100kDa to deliver their gene and homologous recombination matrix to the patient's muscular tissue for the gene therapy of hereditary diseases and to create new-generation medicine based on them for human genetic diseases, in particular, for Duchenne muscular dystrophy.

The medicine that is to be developed as part of the the project will make it possible to cure different types of this disease.

FUNDING: Ministry of Science and Higher Education of the Russian Federation

CLIENT: BIOCAD Biopharmaceutical Company **PARTNER:** ПОЛИТЕХ

GENERATION OF DIGITAL TWINS FOR SOPHISTICATED PRODUCTS BASED ON AN END-TO-END DESIGN METHODOLOGY INVOLVING MULTIDISCIPLINARY NUMERICAL MODELLING (EDUCATIONAL PROJECT)

CDMM

Center for Design, Manufacturing and Materials

As part of this course, business professionals will work together with a Skoltech team to generate a digital twin of a test product intended for an integrated performance modelling of the system.

The digital twin, a multiscale numerical model, may be used to evaluate the performance of the product to be designed within a system-level global model and for predictive equipment maintenance in combination with the Internet of Things platform.

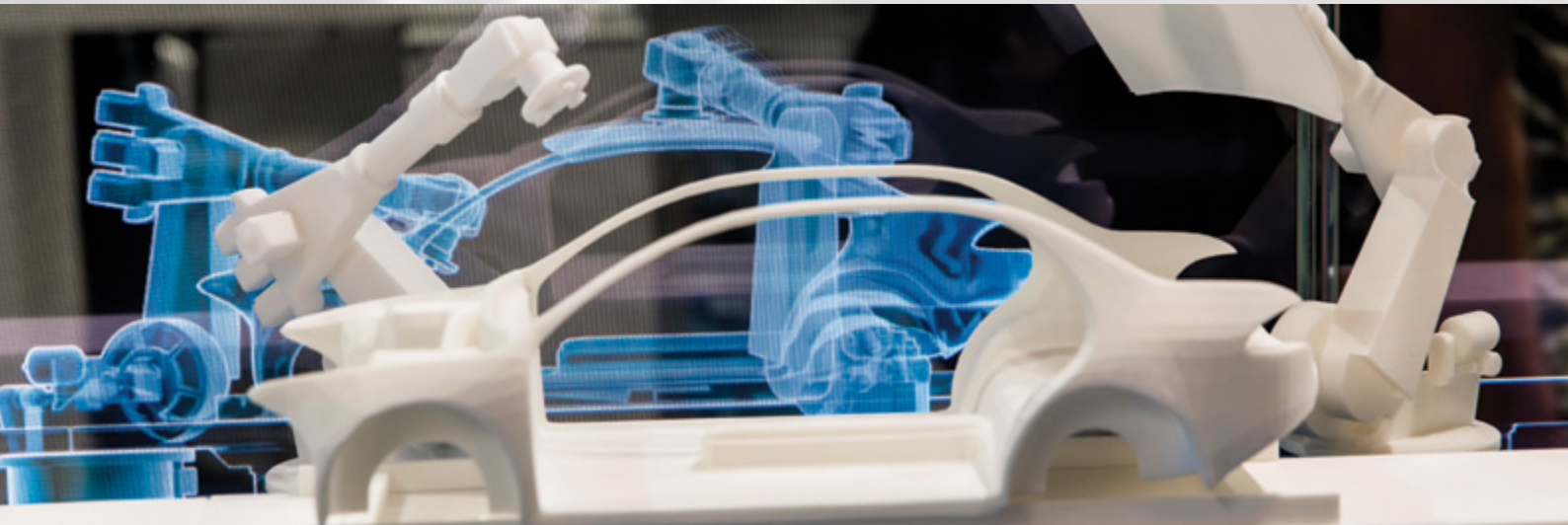
THE COURSE COVERS:

- Basic numerical modelling of engineering systems using the bond graph method and the finite elements method in Simcenter Amesim, Simcenter 3D, ANSYS.
- Basic system engineering and product computational configuration management in LMS System Synthesis package.
- Basic model optimization, reduction and research of parameter space by means of Optimus, pSeven, and HEEDS.
- Basic calculated data management on the Teamcenter PLM platform.

The business professionals will gain hands-on experience, generating the digital twins of assemblies using dedicated software packages, where they will deal with a real product and the PLM system over the course of engineering the model-based design.

POTENTIAL CLIENTS:

Heads of design units, design engineers, computing engineers, design automation managers and professionals.



INNOVATIVE METHODS AND TOOLS TO SUPPORT THE PROCESS OF TECHNOLOGY ROADMAPPING

Development of innovative methods and tools to support the model-based process of creating a road map for technology. A model-based approach allows numerical models to be created to develop technology and the relations between various new projects (properties that need to be achieved, necessary costs).

SSC

Space Center

The projects to be implemented will be selected based on both the expert evaluation and quantitative performance evaluation.

The methodology that will be developed will enable major industrial groups to optimize and balance the portfolio of R&D activities they fund and conduct.

CLIENT AIRBUS

DEVELOPMENT OF AUTOMATED FOREST MANAGEMENT TECHNOLOGY INVOLVING HYPERSPECTRAL REMOTE SENSING

The aim of this project is for Skoltech researchers to develop algorithms to establish the forest species composition based on multi- and hyperspectral recordings obtained using drones and remote land sensing satellites.

SSC

Space Center

The algorithms to be developed will be used for automated forestland inventory. Forestland inventory is currently carried out through fieldwork, and the creation of inventory technology for forest species using remote methods will therefore significantly reduce costs and shorten the time frame for this work.

PARTNER: ЦЕНТР КОСМИЧЕСКИХ ТЕХНОЛОГИЙ И УСЛУГ

SERVICES FOR INDUSTRIAL COMPANIES - HACKATONS

SKOLTECH HOSTS HACKATHONS – PROFESSIONAL FORUMS ON VARIOUS AREAS OF SOFTWARE DEVELOPMENT (PROGRAMMERS, DESIGNERS, MANAGERS) TO SEARCH FOR SOLUTIONS TO SPECIFIC REAL-LIFE PROBLEMS TOGETHER.

In 2018, Skoltech held the following major hackathons:

AKADOTON

22–24 June 2018: a three-day marathon co-sponsored with AKADO Telecom, which brought together over 100 representatives in 23 teams.

The prize money amounted to 450,000 roubles

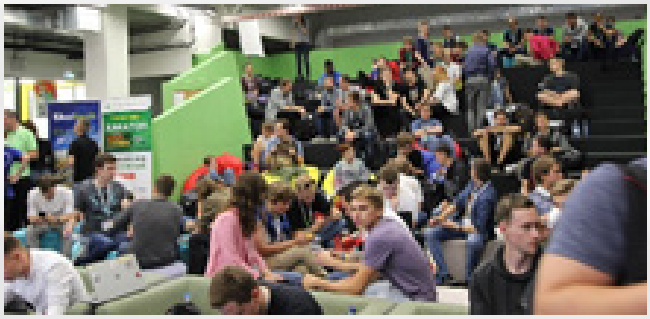
Participants at the hackathon developed innovative AI-based products and services and suggested ideas to create virtual assistant algorithms and effectively implement them. The projects were evaluated by a panel chaired by Sergey Nazarov, CEO of AKADO Telecom. The panel was composed of representatives from Skoltech, AKADO Telecom, and partner companies. The TOP-3 teams received prize money based on the competition results. The other teams received the partner prizes. The strongest participants were rewarded with Skoltech entry bonuses and internships with AKADO Telecom.

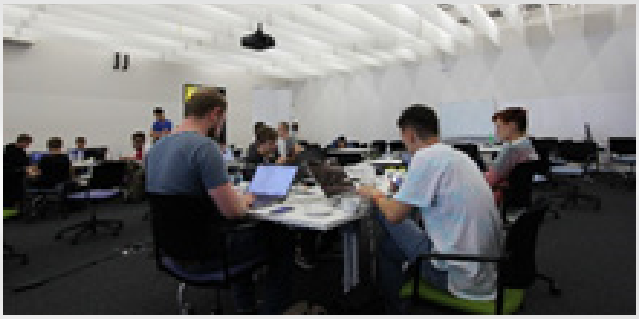
PARTNERS

HACKTHINGS HACKATHON

7–9 September 2018: HackThings hackathon: Sberbank and Internet of Things at Skoltech.

The prize money amounted to 500,000 roubles





Participants at the hackathon had to solve the problems related to specific applications of the Internet of Things:

- IoT: City, House and Transport – From a smart outlet to urban infrastructure management systems
- IoT: Health – From a smart heart-rate monitor to telemedicine
- IoT: Agro – Farming solutions
- IoT: Finance – From a smart price tag to stock exchange systems
- IoT: Data – From a smart sensor to a data analysis platform

PARTNERS

NEUROHACKATHON

16–18 November 2018: Neurohackathon co-sponsored by Skoltech, Philips, and other partners.

The prize money amounted to 1,000,000 roubles.

The hackathon involved young professionals in the field of data analysis, machine learning, artificial intelligence and neurophysiologists. The participants had to solve problems in various fields of neurotechnology – innovative approaches to diagnosing sclerosis, methods for controlling prostheses with the power of thought, and the development of methods to track cybergamers' in-process reactions using CoBrain-Analytics. These activities were combined with a game track featuring comedian Sergey Detkov and a humour quality evaluation simulator.

PARTNERS

CONTINUING PROFESSIONAL EDUCATION (CPE)

MODULAR COURSES FOR INDUSTRY

Skoltech is an international university, which makes it possible to attract professionals and professors from the best foreign universities to contribute to the educational process and research projects. Being integrated in global science enables Skoltech to run unique educational courses that have yet to be matched in Russia.

MODULAR COURSES FOR INDUSTRY:

- Possibility of creating tailored programs over a period from one day up to several weeks
- Access to the best experts from international universities
- Flexible pricing policy
- Possibility of bringing the program to the client's location

Skoltech offers modular educational courses both for engineers and managers in a variety of vocational subjects.

www.skoltech.ru/industriya/modular-courses-for-industry/

EDUCATIONAL COURSES FOR ENGINEERS:

- Data Analysis
- Oil & Gas Technology
- Composite Technology
- Additive Technology
- Hi-Tech Product Life Cycle Management
- System Engineering

EDUCATIONAL COURSES FOR MANAGERS:

- Data Analysis
- Hi-Tech Product Life Cycle Management
- Additive Technology
- Composition Materials
- System Engineering
- Strategic Technological Management

EDUCATIONAL COURSES IN INNOVATION-DRIVEN DEVELOPMENT AND INTELLECTUAL PROPERTY MANAGEMENT:

- Basics of intellectual property for managers of manufacturing businesses
- Intellectual property management for managers of manufacturing businesses
- Innovation-driven management
- Innovation engineering (ideas for implementation)
- Innovation business model: open-end, digital, global

ANALYTICS

KEY AREAS OF ANALYTICAL WORK:

- The priorities of policy on science within the context of economic modernization and forming policies for innovation
- Organizational changes in Russian science
- Regional aspects of policy on science and technology
- Bringing Russian science to the international arena
- Mobility, networks, and the exchange of technology professionals, scientists, and researchers
- Courses for the development of Russian science as part of the educational process
- Managing the system of Russian science
- Forming the technological industrial priorities to create an internationally competitive market
- New interface mechanisms for science and industry
- Technological standards and platform economy

CONTACTS

INDUSTRIAL PROGRAMS DEPARTMENT

DMITRY KATALEVSKY
Director for Industrial Programs
d.katalevsky@skoltech.ru

SHAMKHAL DZHABRAILOV
Deputy Director for Industrial Oil & Gas Programs
s.jabrailov@skoltech.ru

GENNADY RUDENSKY
Manager for Grants and Contracts
g.rudensky@skoltech.ru

PAVEL DOROZHKIN
Deputy Director, Industrial Programs Department,
Associate Professor
p.dorozhkin@skoltech.ru

CENTERS FOR RESEARCH, EDUCATION AND INNOVATION (CREI)

CENTER FOR COMPUTATIONAL AND DATA-INTENSIVE SCIENCE AND ENGINEERING (CDISE)
IVAN KHLEBNIKOV
i.khlebnikov@skoltech.ru

CENTER FOR HYDROCARBON RECOVERY (CHR)
MIKHAIL SPASENNYKH
m.spasennykh@skoltech.ru

CENTER FOR ADVANCED STUDIES (CAS)
OLEG LOIKO
o.loiko@skoltech.ru

SKOLTECH SPACE CENTER (SSC)
ANDREY POTAPOV
a.potapov@skoltech.ru

RESEARCH CONTRACTS OFFICE

NATALIA KOSMODEMYANSKAYA
Head of Office
n.kosmodemyanskaya@skoltech.ru

ANDREY GRISHIN
Manager
a.grishin@skoltech.ru

ANALYTICAL R&D DEPARTMENT

IRINA DEZHINA
Head of Department
i.dezhina@skoltech.ru

TIMUR GAREEV
Deputy Director of Department
t.gareev@skoltech.ru

CENTER FOR DESIGN, MANUFACTURING AND MATERIALS (CDMM)
YURI DEREVNIN
y.derevnin@skoltech.ru
IVAN POPOV
i.popov@skoltech.ru

CENTER OF LIFE SCIENCES (CLS)
VERA RYBKO
v.rybko@skoltech.ru

CENTER FOR NEUROBIOLOGY AND BRAIN RESTORATION (CNBR)
NATALYA PODSOSONNAYA
n.podsosonnaya@skoltech.ru

DIGITAL FARMING LABORATORY
ROMAN KULIKOV
r.kulikov@skoltech.ru

CENTER FOR ENERGY SCIENCE AND TECHNOLOGY (CEST
DMITRY POGOZHEV
d.pogozhev@skoltech.ru

CENTER FOR OPEN LEARNING (COL)
POLINA ELIZAROVA
p.elizarova@skoltech.ru

SHARED FACILITIES OFFICES (SFO
ALEXEY DENISOV
a.denisov@skoltech.ru

CENTER FOR PHOTONICS AND QUANTUM MATERIALS (CPQM)
ARKADY SHIPULIN
a.shipulin@skoltech.ru

OFFICE FOR INDUSTRIAL COOPERATION AND CONTINUING PROFESSIONAL EDUCATION (CPE) PROGRAMS

IVAN BOGDANOV
Head of Office
i.bogdanov@skoltech.ru

ALENA NORKO
Руководитель по развитию индустриального образования
a.norko@skoltech.ru

Skoltech

Skolkovo Institute of Science and Technology

Skolkovo Institute of Science and Technology
Skolkovo Innovation Center,
Bolshoy boulevard 30, build. 1
www.skoltech.ru/en