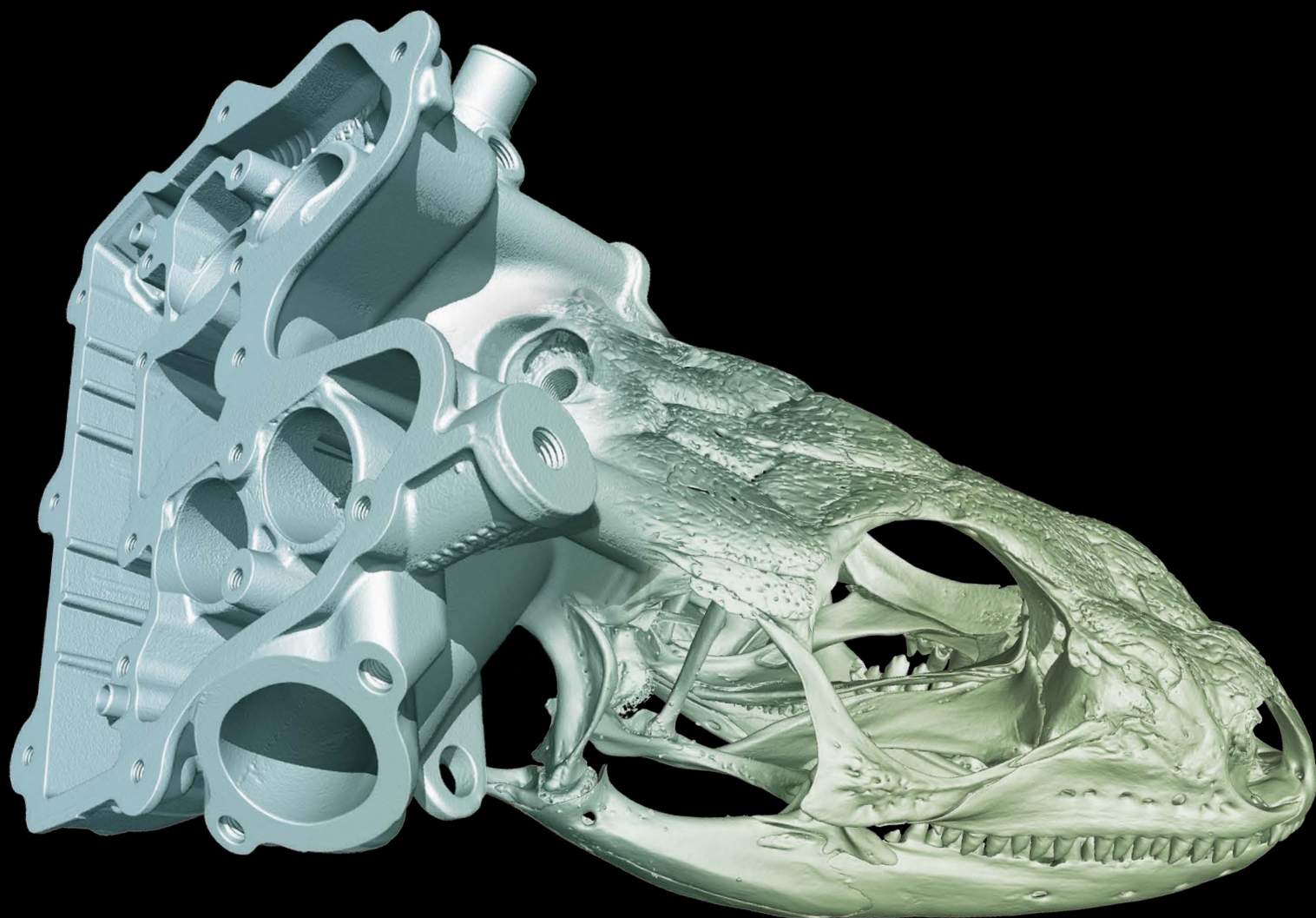




RESEARCH GROUP
ADVANCED INSTRUMENTATION AND METHODS
FOR MATERIALS CHARACTERIZATION

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MAIN ACTIVITIES

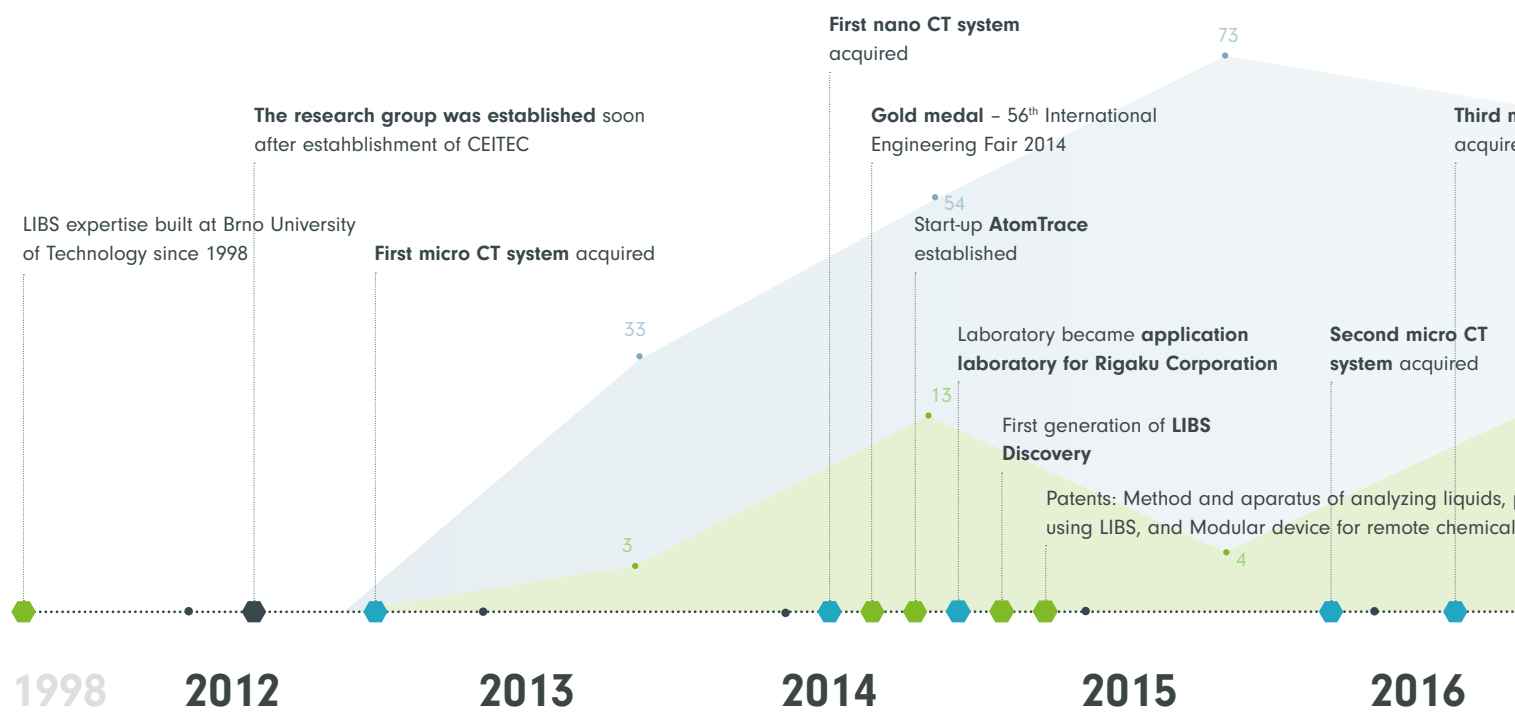
Advanced Instrumentation and Methods for Materials Characterization group performs R&D activities within a broad range of topics including laser based spectroscopy, optics, and X-Ray computed tomography. Our main objectives are focused on providing insights into current scientific trends and future demands. Research capabilities of the group have been already demonstrated in fundamental research and also through a strong cooperation with a variety of industrial partners in applied research.

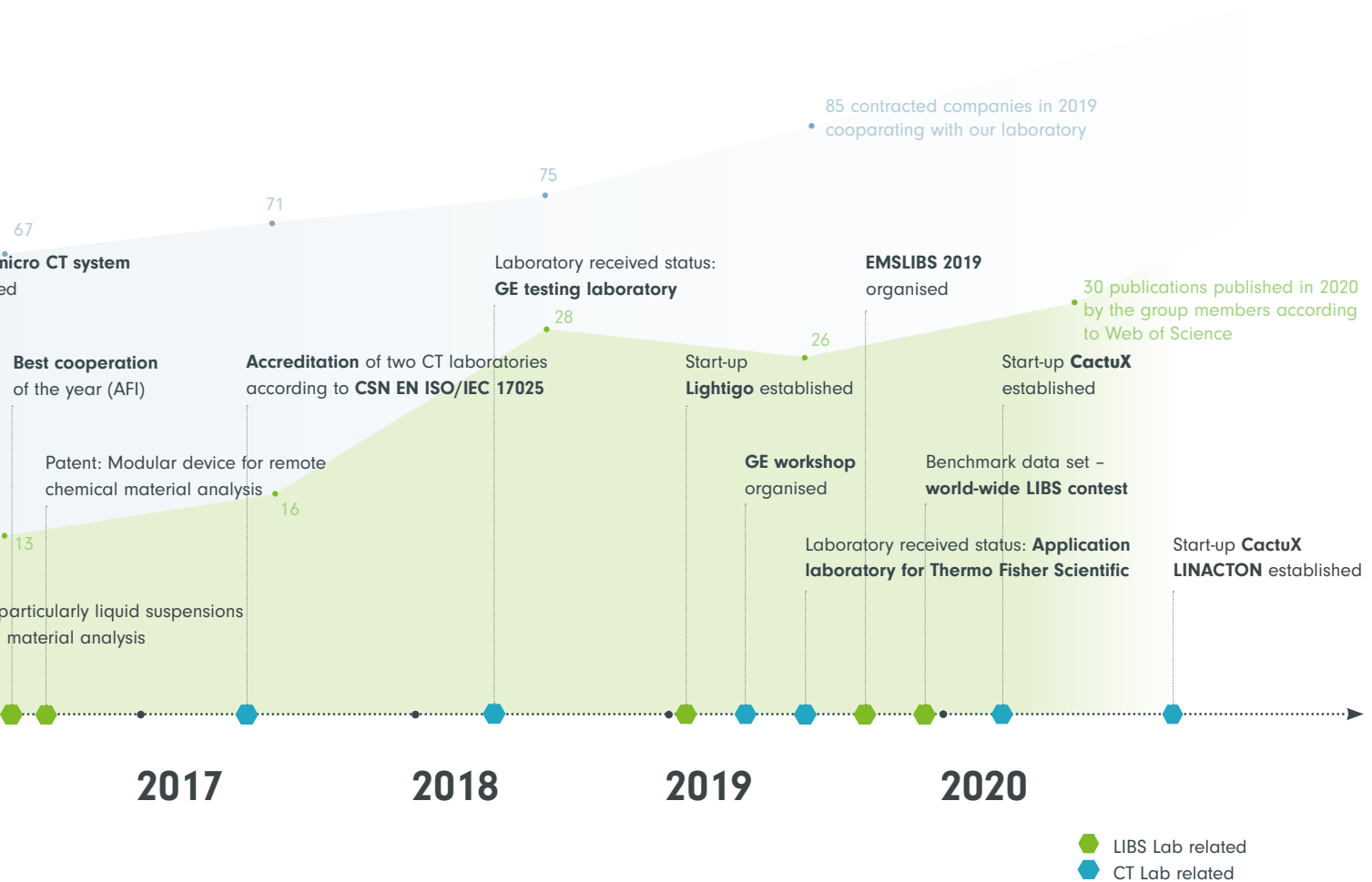
OUR VISION AND MISSION

Our vision is to transfer technology outputs from high-end science to daily routine.

Our mission is to bridge the gap between technical and bio-science, develop state-of-the-art instrumentation, commercialize technology and know-how, and provide professional analytical services.

RESEARCH GROUP IN TIME







 CETEC

INDUSTRY COOPERATION

Cooper Standard

Crytur

DENSO Manufacturing Czech

Epina ImageLab

Garrett - Advancing Motion

Hanon Systems

Mann+Hummel

One3D

PANASONIC

Plastics Cluster

Rigaku

Robert Bosch

SAB Aerospace

Xi'an Sirupe Photoelectric Technology

Smart Laser & Plasma Systems

Tenneco

Thermo Fisher Scientific

Varroc Lighting Systems

Waygate Technologies



SCIENTIFIC COOPERATION

Brno University of Technology

Czech Academy of Sciences

Elettra Sincrotrone Trieste

Federal Inst. for Materials Research and Testing

HiLASE

Institut Pasteur

Johannes Kepler University Linz

Karolinska Institutet

Masaryk University

Medical University of Vienna

Ocean University of China

Tokushima University

University of Arizona

University of Bari, Dep. of Chemistry

University of Jyväskylä

University of Malaga

University of Massachusetts Lowell

Vienna University of Technology



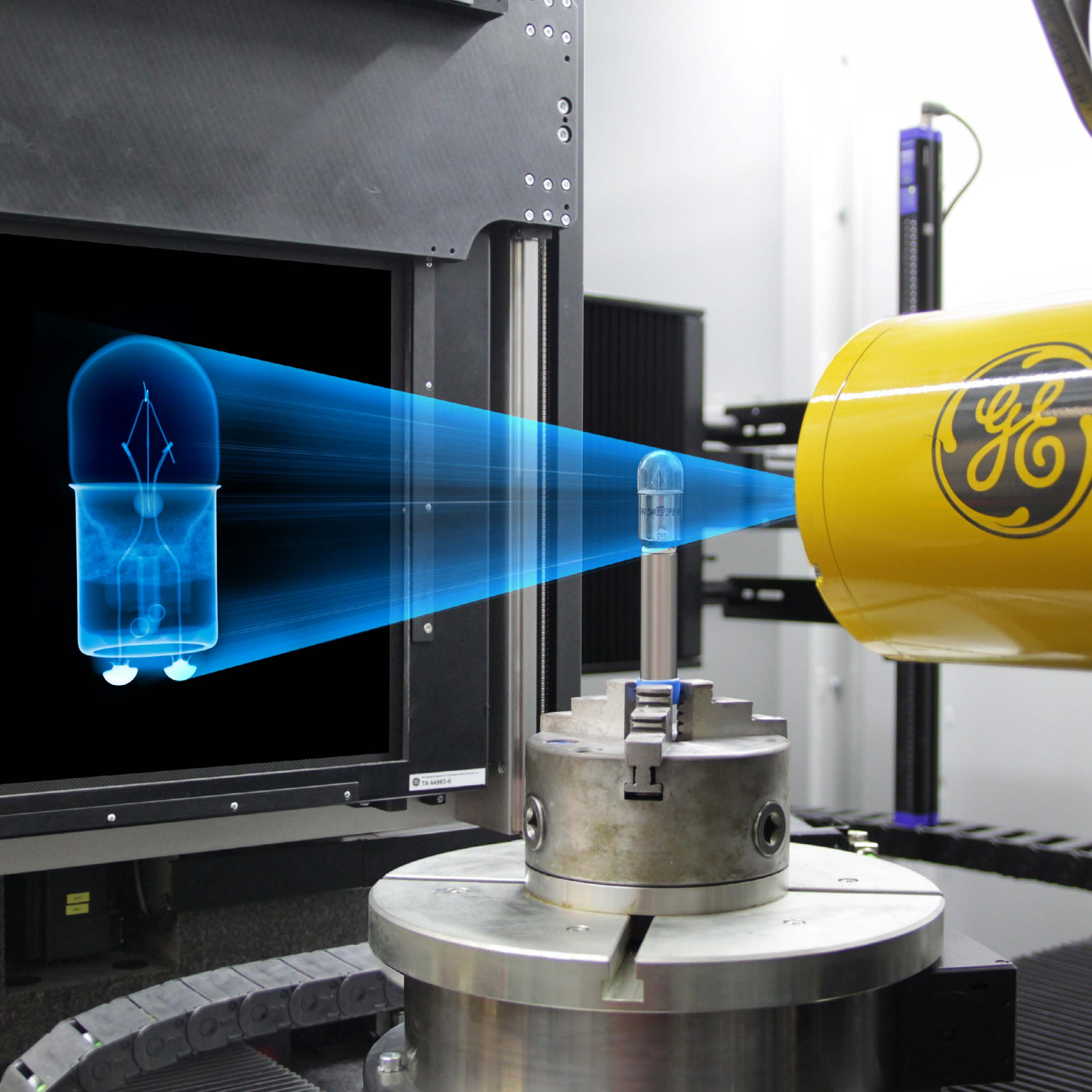


The laboratory of X-ray micro and nano computed tomography is engaged in research and development of tomographic methods and their applications in various scientific and engineering fields. It deals with the development of μ CT technology in cooperation with the world's leading manufacturers of CT. The laboratory is accredited according to CSN EN ISO/IEC 17025 and conducts contractual and grant-oriented research with the industrial sector, in which this technology is widely used. The portfolio of modern CT systems enables the analysis of a wide range of parts and assemblies for many applications. It is possible to achieve a resolution from hundreds of microns to hundreds of nanometres and to analyse different shapes, sizes and materials.

MAIN FIELDS OF INTEREST

Industrial CT Expertize
Basic and Applied Research

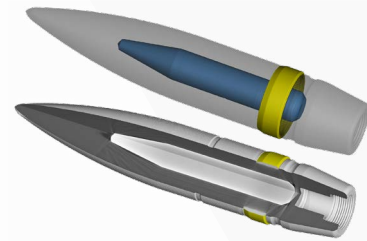
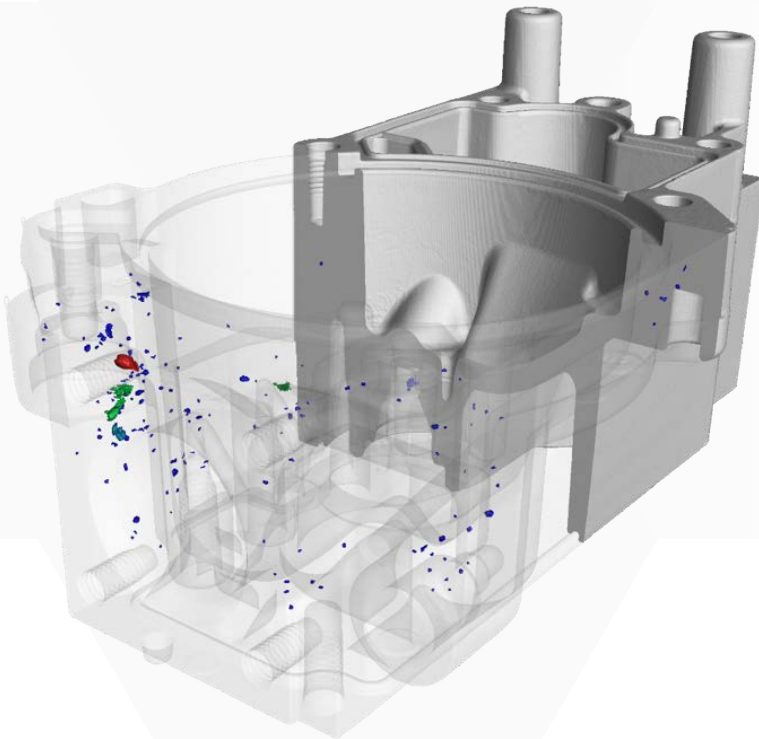
More on
ctlab.ceitec.cz



INDUSTRIAL CT EXPERTIZE

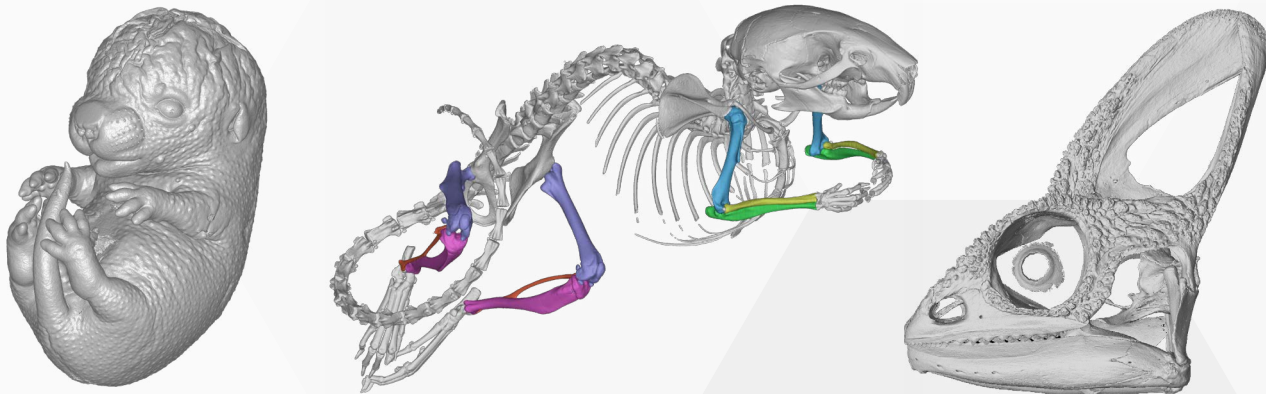
Implementing CT to industry

- Non-destructive testing of final and developing products
- Characterisation of internal structure of materials
 - Porosity/Inclusion Analysis
- Inspection of dimensions, geometric tolerances, shapes of a component and its position in assembly
- Characterization and analysis of fibre reinforced materials, foam structures and soldered joints
- Injection mold correction
- Optimization of additive manufacturing
- Testing of components in working condition
 - Temperature
 - Pressure



BASIC AND APPLIED RESEARCH

- CT metrology
 - Determination of spatial resolution and CT measurement uncertainties
 - New reference objects development
- Software development for CT devices
 - Tomographic reconstruction
 - Artefact reduction methods
- Advanced imaging techniques
 - Development of phase contrast imaging
 - Dual-energy CT and correlation with 2D analytical techniques
- CT data processing
 - Noise reduction
 - CT image segmentation
 - Artificial intelligence and deep learning
- Biology
 - 3D reconstruction of rodent organ and quantification of differences
 - Contrasting protocols for soft tissue
- Tissue engineering
 - 3D characterization of internal structure of new materials
- Geology
 - Mapping of pores/inclusions distribution and morphology
- Archaeology
 - Study of unique ancient objects



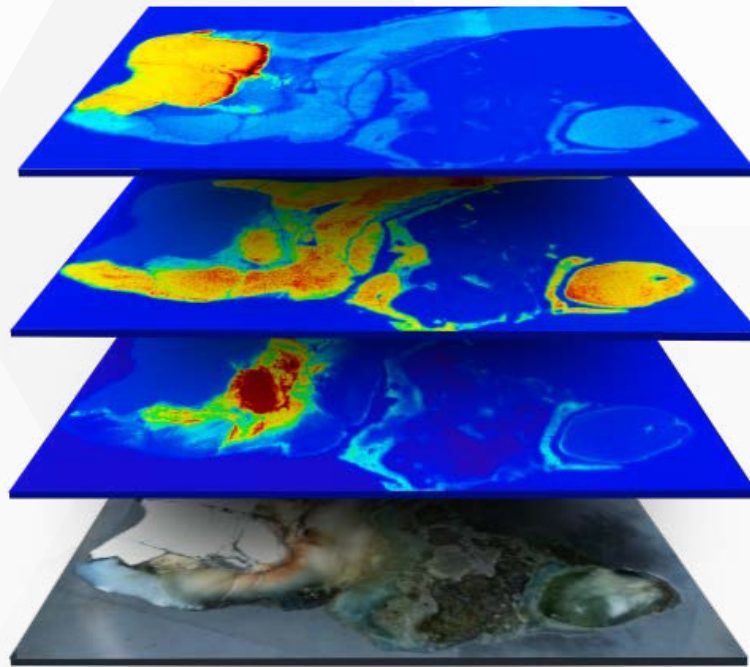


The Laboratory of Laser Spectroscopy focuses mainly on the Laser-Induced Breakdown Spectroscopy (LIBS) and related reference (based on inductively coupled plasma or X-ray fluorescence) and complementary techniques (Raman spectroscopy). The Laboratory strives to make progress in the field of LIBS in basic and applied research, and to excellence therein through the development of state-of-the-art instrumentation and analytical methodology. Thus, the Laboratory fosters the transfer of technology to industry and daily use.

MAIN FIELDS OF INTEREST

Hardware and software development
Basic and Applied Research

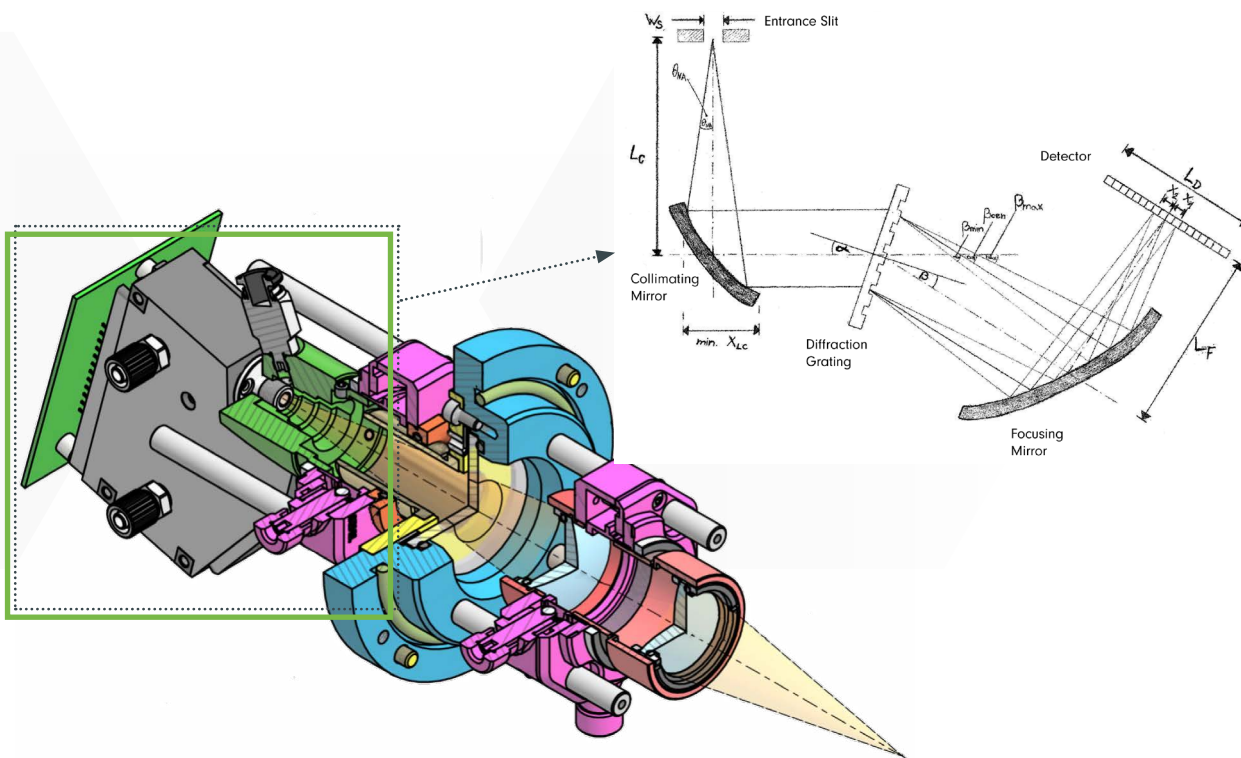
More on
libs.ceitec.cz



Multi-elemental chemical imaging

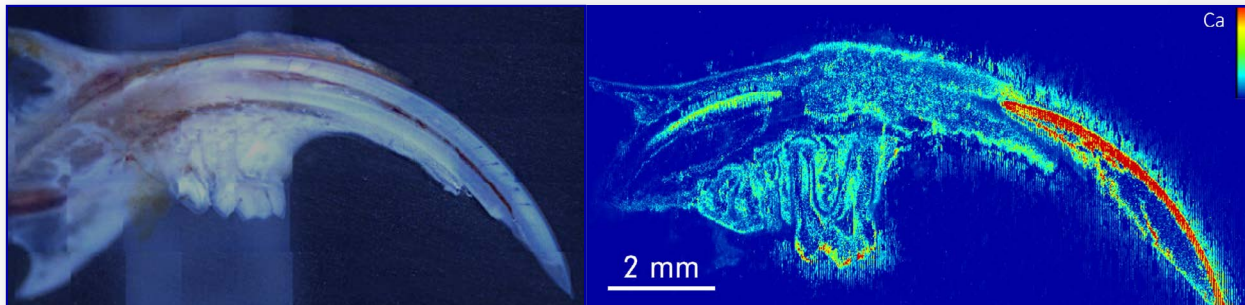
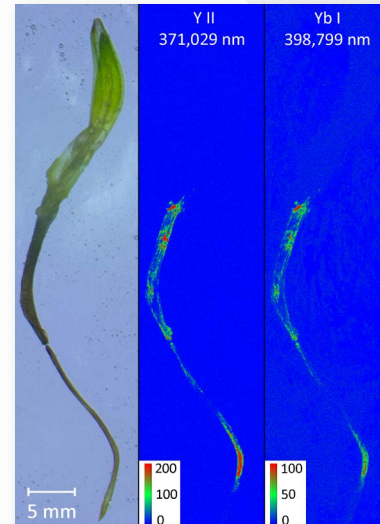
HARDWARE AND SOFTWARE DEVELOPMENT

- Development of task-specific instruments
 - Optical and opto-mechanical design of laser spectroscopy instruments
 - Mechanical design of robust, on-line systems with remote and/or stand-off detection
 - Development of specialized control softwares and graphical user interfaces.
 - Prototyping and testing of designed instruments and modules
 - Implementation of machine learning
- Custom development for the industry
 - Plastic industry (detection of toxic metals; e.g., Cd, Hg, Pb and Cr(VI));
 - Foundry and metallurgy (detection of C, S, P; prediction of material properties);
 - Automotive (characterization of thin surface coatings, selective detection of elements in materials layers);
 - Mining (rock identification, C).

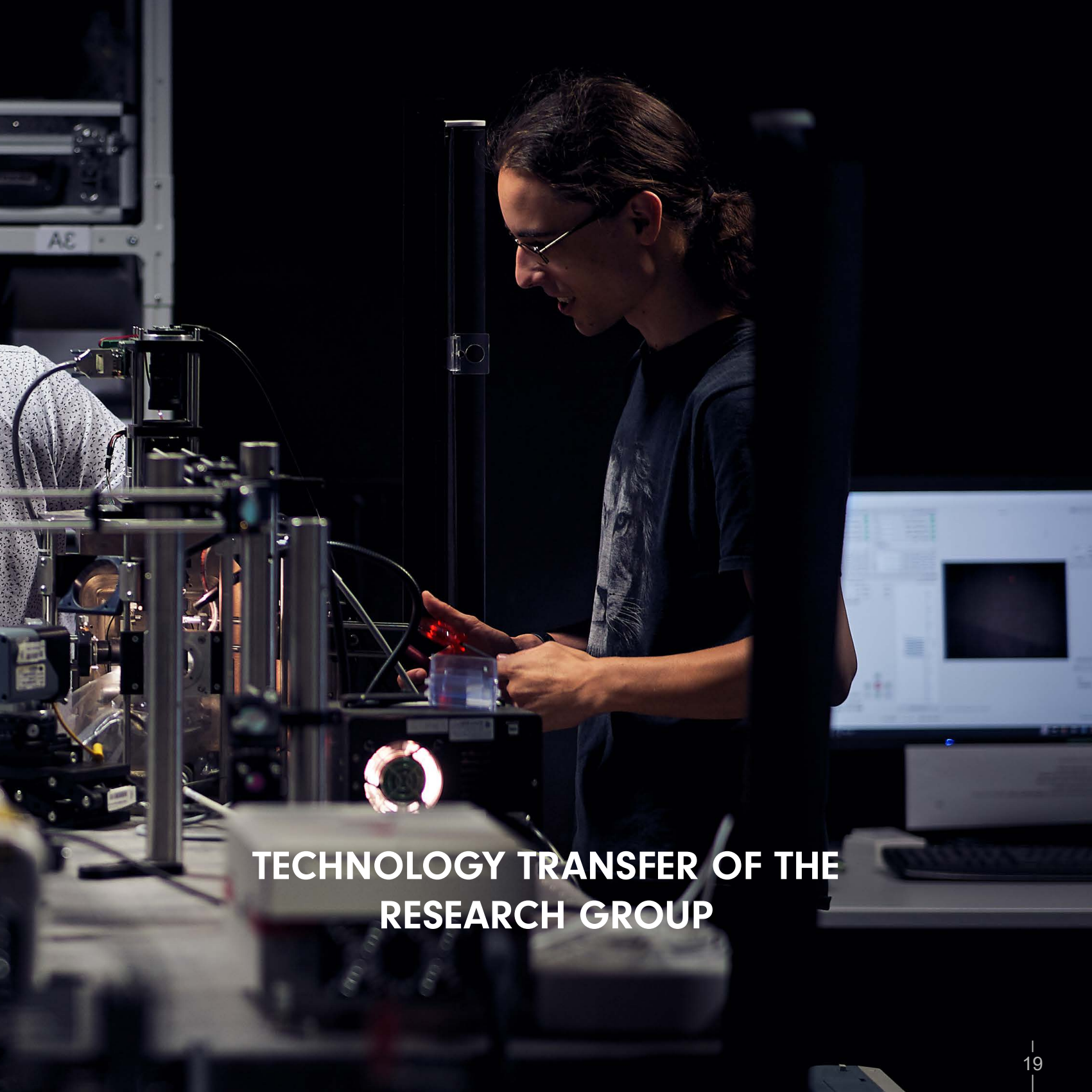


BASIC AND APPLIED RESEARCH

- Geology
 - In situ analysis of geological samples
 - Quantification of trace elements
 - Classification of minerals
 - Validation of gemstones
- Plastic industry
 - On-line control of production process
 - Quality check of input / output materials
 - Heavy metals detection
- Biology
 - Clinical and non-clinical research
 - Detection of NP-tags and metallomes for immunoassays
 - Elemental imaging of soft and hard tissues
 - Environmental diagnostics
 - Toxicology and nanoparticles detection, immunodetectors
- Plasma physics
 - Fundamental research and characterization of laser-induced plasmas
 - Shadowgraphy, plasma imaging and tomography
 - Modelling of laser-induced plasmas
- Data processing and data mining
 - Development of machine learning methods for, e.g., transfer library
 - Implementation of machine learning for sample classification
 - Correlative spectroscopy







TECHNOLOGY TRANSFER OF THE RESEARCH GROUP



Research and development company focused on rapid multi-elemental analysis and chemical imaging. Founded in 2019, Lightigo started its activities with more than 20 years of R&D experience with the Laser-Induced Breakdown Spectroscopy (LIBS) in the Laboratory of Laser Spectroscopy of CEITEC. The main mission is to transfer the LIBS technology and its benefits to the market in the form of fast, accurate, and reliable analytical devices. The core product FireFly is a laboratory instrument specialized in rapid multi-elemental chemical imaging of solid samples of various types with the emphasis on the high performance, stability, and user experience. The cooperation with CEITEC enables following the last discoveries in the field of LIBS, to test cutting edge LIBS applications and to better understand the customers' needs.



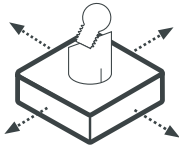
producing LIBS
instruments

2019
founded

Contact us
www.lightigo.com
info@lightigo.com

CACTUX

CactuX develops and produces addons for industrial and laboratory X-ray Computed Tomography (CT) systems. CactuX was founded in 2020 by researchers from CT Lab in order to ensure an efficient technology transfer of selected outcomes from scientific research to business. The company's main mission is to provide the market with enhancers that make the CT analysis easier, faster and more accurate. The product line SaguarioX includes wireless motorized xy translation stages specifically designed for quick sample mounting and easy sample centering respectively to the X-ray tube in μ CT stations. The product line of special phantoms provides tools for metrological characterization, calibration, and testing of nano and μ CT systems. Further cooperation with the CT Lab allows to connect current scientific research and industry development, which makes the workflow of a CT technician operating various CT systems more effective.



producing addons
for CT instruments

2020
founded

Contact us
www.cactux.cz
info@cactux.cz



LINACTON

by CACTUX

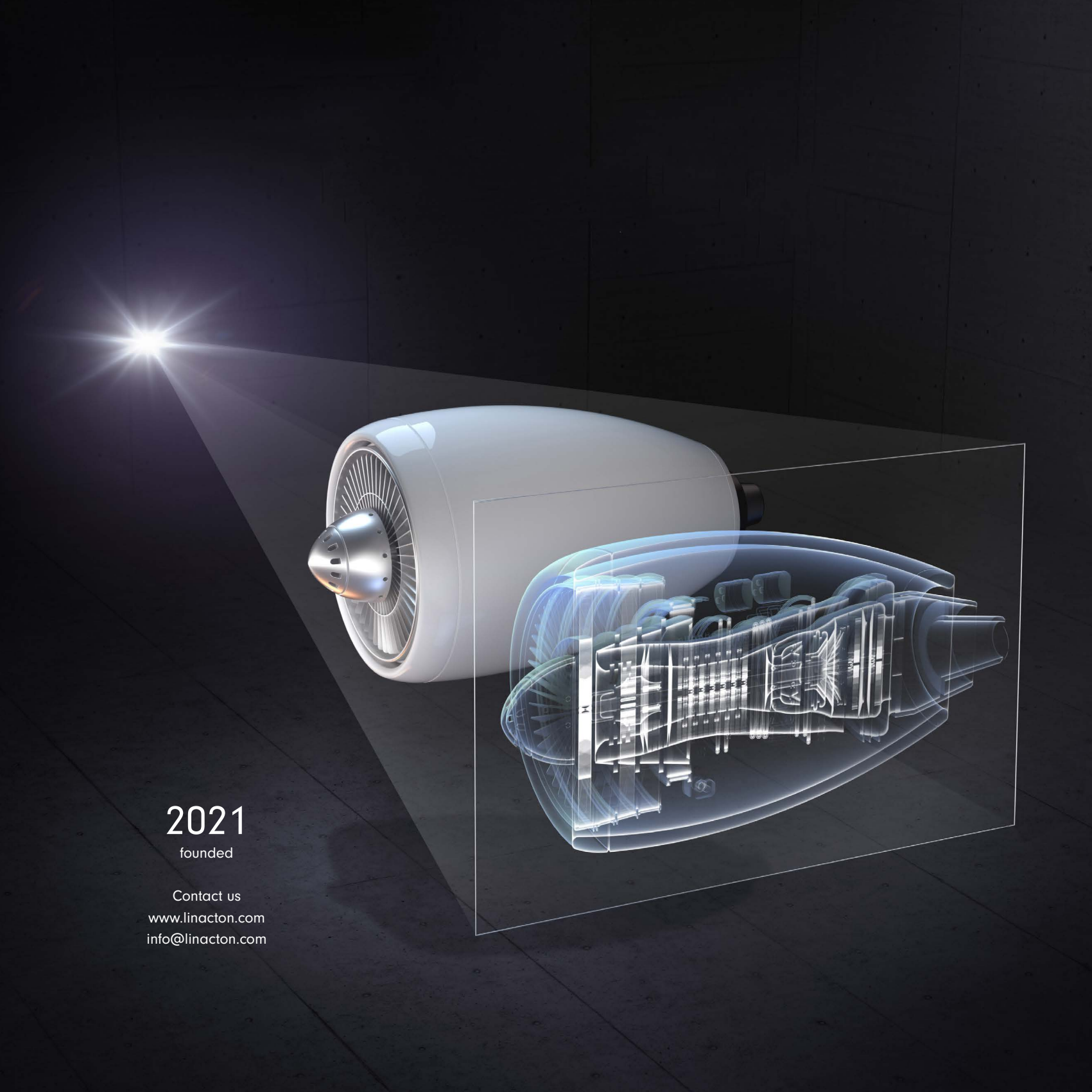
Based on a long-term cooperation with industry, the CT system manufacturers themselves as well as on the gained experience, the research center Central European Institute of Technology (CEITEC BUT) and CactuX LINACTON are joining together to expand their portfolio with high-energy X-ray computed tomography. For this purpose, a project called LINACTON is being created. The mission is to build a new center with this technology and make it available for general industrial use. This technology is going to improve scientific, engineering and technical knowledge in line with current industrial trends such as automation (Industry 4.0) and electrification (e-mobility).

CactuX LINACTON is a start-up company of CEITEC BUT. CEITEC BUT has been working with CT application and development for more than 10 years. Working together with selected global producers of CT instrumentation, it managed to establish several intercooperating laboratories. These laboratories are equipped with complex and complementary state-of-the-art devices, covering a wide range of tomographic analysis. Besides fundamental research in different fields, the activities focus on a close cooperation with industry for which these laboratories provide a high- quality level of digital X-ray radiographic and tomographic expertise.



NDT of large scale and
heavy samples

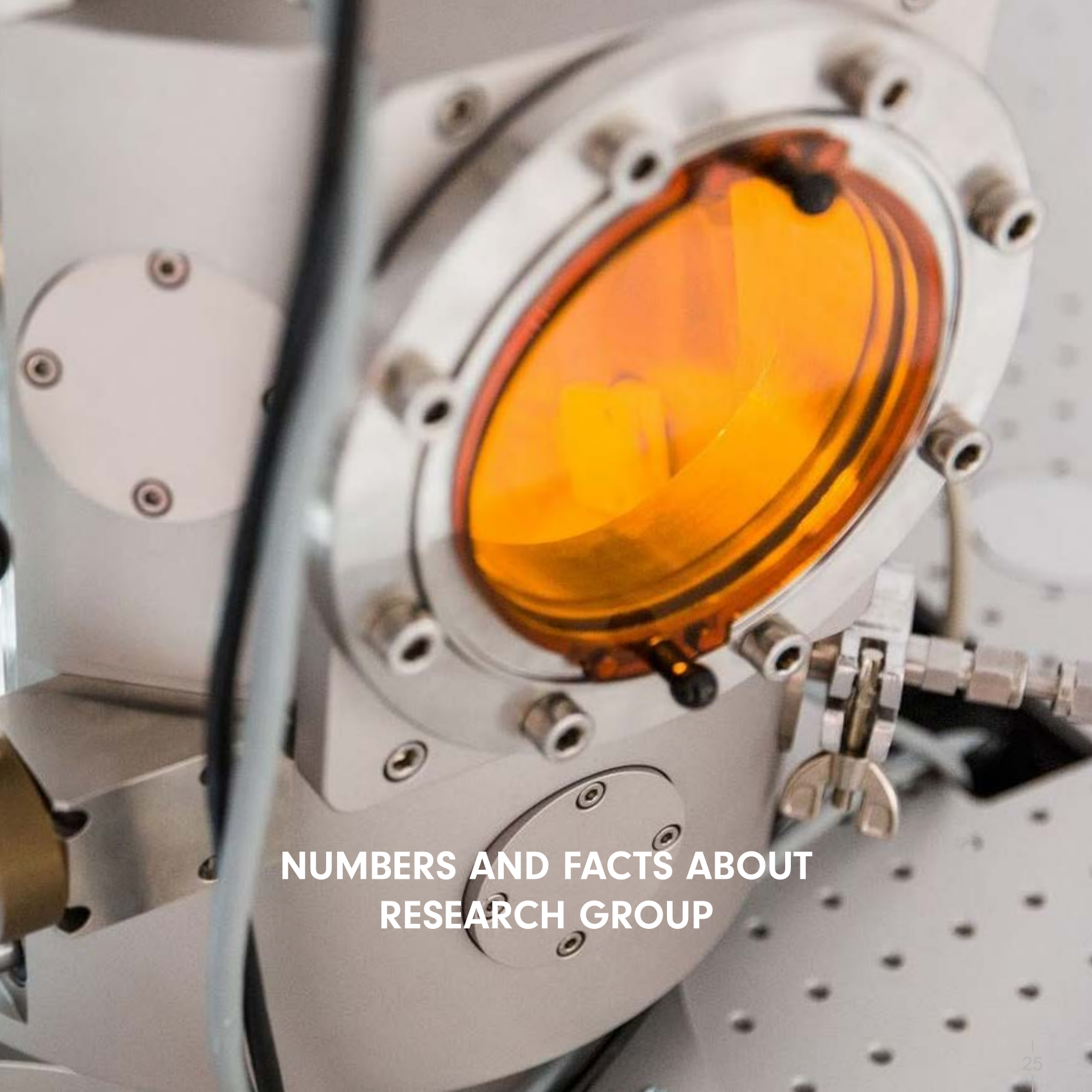
New generation
LINAC-BASED
industrial CT



2021
founded

Contact us
www.linacton.com
info@linacton.com





NUMBERS AND FACTS ABOUT RESEARCH GROUP

RECENT TOP ARTICLES

Laboratory of X-ray micro and nano computed tomography

HEUDE, E.; TESAROVA, M.; SEFTON, E. M.; JULLIAN, E.; ADACHI, N.; GRIMALDI, A.; ZIKMUND, T.; KAISER, J.; KARDON, G.; KELLY, R. G.; TAJBAKSH, S., 2018: **Unique morphogenetic signatures define mammalian neck muscles and associated connective tissues**. ELIFE, doi: 10.7554/eLife.40179

KALASOVA, D.; ZIKMUND, T.; PINA, L.; TAKEDA, Y.; HORVATH, M.; OMOTE, K.; KAISER, J., 2020: **Characterization of a laboratory-based X-ray computed nanotomography system for propagation-based method of phase contrast imaging**. IEEE TRANSACTIONS ON INSTRUMENTATION AND MEASUREMENT, doi: 10.1109/TIM.2019.2910338

COMAI, GE.; TESAROVA, M.; DUPE, V.; RHINN, M.; VALLECILLO-GARCIA, P.; DA SILVA, F.; FERET, B.; EXELBY, K.; DOLLE, P.; CARLSSON, L.; PRYCE, B.; SPIZT, F.; STRICKER, S.; ZIKMUND, T.; KAISER, J.; BRISCOE, J.; SCHEDL, A.; GHYSELINCK, NB.; SCHWEITZER, R.; TAJBAKSH, S., 2020, **Local retinoic acid signaling directs emergence of the extraocular muscle functional unit**. PLOS BIOLOGY, doi: 10.1371/journal.pbio.3000902

KIMURA, T.; BOSAKOVA, M.; NONAKA, Y.; HRUBA, E.; YASUDA, K.; FUTAKAWA, S.; KUBOTA, T.; FAFILEK, B.; GREGOR, T.; ABRAHAM, S. P.; GOMOLKOVA, R.; BELASKOVA, S.; PESL, M.; CSUKASI, F.; DURAN, I.; FUJIWARA, M.; KAVKOVA, M.; ZIKMUND, T.; KAISER, J.; BUCHTOVA, M.; KRAKOW, D.; NAKAMURA, Y.; OZONO, K.; KREJCI P., 2021: **An RNA aptamer restores defective bone growth in FGFR3-related skeletal dysplasia in mice**. SCIENCE TRANSLATIONAL MEDICINE, doi: 10.1126/scitranslmed.aba4226

HANKEOVA, S.; SALPLACHTA, J.; ZIKMUND, T.; KAVKOVA, M.; VAN HUL, N.; BRINEK, A.; SMEKALOVA, V.; LAZNOVSKY, J.; DAWIT, F.; JAROS, J.; BRYJA, V.; LENDAHL, U.; ELLIS, E.; NEMETH, A.; FISCHLER, B.; HANNEZO, E.; KAISER, J.; ANDERSSON E. R., 2021, **DUCT reveals architectural mechanisms contributing to bile duct recovery in a mouse model for Alagille syndrome**. ELIFE, doi: 10.7554/eLife.60916

Laboratory of Laser Spectroscopy

LIMBECK, A.; BRUNNBAUER, L.; LOHNINGER, H.; POŘÍZKA, P.; MODLITBOVÁ, P.; KAISER, J.; JANOVSKÝ, P.; KERI, A.; GALBÁCS, G., 2021: **Methodology and applications of elemental mapping by laser induced breakdown spectroscopy**, doi: 10.1016/j.aca.2020.12.054

KÉPEŠ, E.; VRÁBEL, J.; STRÍTEŽSKÁ, S.; POŘÍZKA, P.; KAISER, J., 2020: **Benchmark classification dataset for laser-induced breakdown spectroscopy**. SCIENTIFIC DATA 7(1), doi: 10.1038/s41597-020-0396-8

PROHAZKA, D.; POŘÍZKA, P.; NOVOTNÝ, J.; HRDLÍČKA, A.; NOVOTNÝ, K.; ŠPERKA, P.; KAISER, J., 2020: **Triple-pulse LIBS: Laser-induced breakdown spectroscopy signal enhancement by combination of pre-ablation and re-heating laser pulses**. JOURNAL OF ANALYTICAL ATOMIC SPECTROMETRY 35(2), doi: 10.1039/C9JA00323A

MODLITBOVÁ, P.; POŘÍZKA, P.; KAISER, J., 2020: **Laser-induced breakdown spectroscopy as a promising tool in the elemental bioimaging of plant tissues**. TRAC-TRENDS IN ANALYTICAL CHEMISTRY 122, doi: 10.1016/j.trac.2019.115729

POŘÍZKA, P.; KLUS, J.; KÉPEŠ, E.; PROHAZKA, D.; HAHN, D.; KAISER, J., 2018: **On the utilization of principal component analysis in laser-induced breakdown spectroscopy data analysis, a review**. SPECTROCHIMICA ACTA PART B 148, doi: 10.1016/j.sab.2018.05.030

RESEARCH GROUP IN NUMBERS

Year	Number of contracted companies	New long term contracts	Year	Scientific Outputs (CEITEC stats.)	Year	Q1 Papers (CEITEC stats.)	Year	Number of Ph.D. students in 2021
2017	71	17	2017	88	2017	17	LIBS	5
2018	75	25	2018	64	2018	23	CT	9
2019	85	29	2019	84	2019	20		
2020	76	36	2020	95	2020	32		

MAIN INSTRUMENTS USED BY RESEARCH GROUP

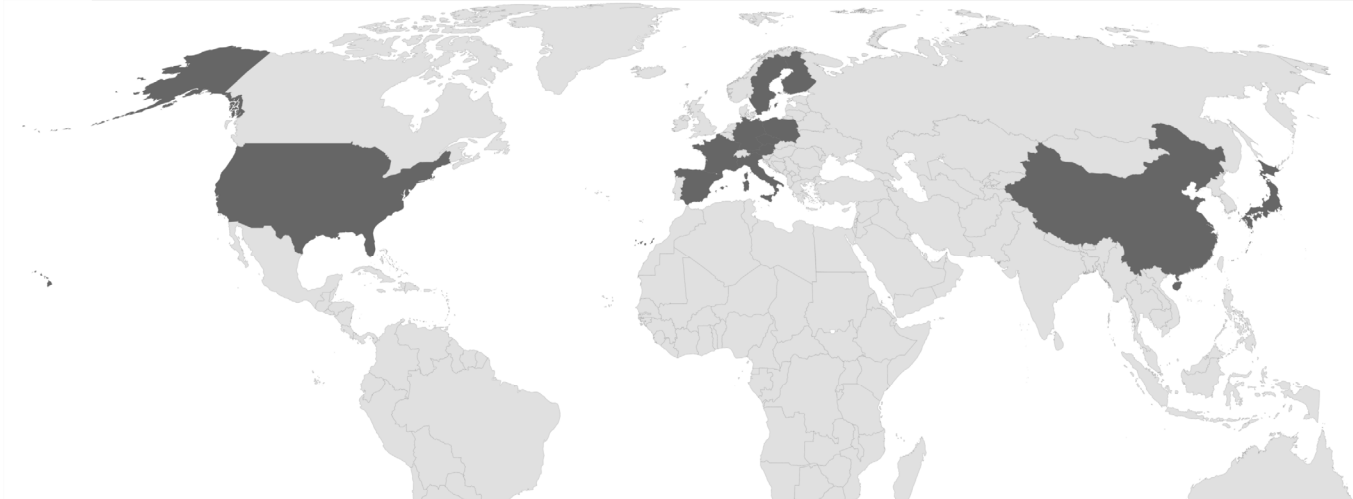
Main instruments used by CT Lab	Software used by CT Lab
GE phoenix v tome x L240	VGStudio MAX
GE phoenix v tome x m	Avizo
RIGAKU nano3DX	MATLAB
Thermo Fisher Scientific Heliscan	GOM inspect
Microme x microfocus X-ray inspection system	MAVI
	3D PDF maker Standalone

Main instruments used by LIBS Lab	Software used by LIBS Lab
LIBS Discovery	Lightigo ImageLab
LIBS Scout	Python
Lightigo FireFly	MATLAB

All statistics are taken from the internal statistics of the research group or CEITEC, actual data from 2021.

COOPERATION OF RESEARCH GROUP

LIBS Lab		CT Lab	
Institution / Company	Country	Institution / Company	Country
Crytur	Czechia	Rigaku	Japan
Plastics Cluster	Czechia	Thermo Fisher Scientific	Czechia
Smart Laser & Plasma Systems	Japan	Waygate Technologies	USA
Xi'an Sirupe Photoelectric Technology	China	SAB Aerospace	Czechia
Epina ImageLab	Austria	PANASONIC	Czechia
Vienna University of Technology	Austria	DENSO Manufacturing Czech	Czechia
University of Massachusetts Lowell	USA	Garrett - Advancing Motion	Czechia
University of Jyväskylä	Finland	Hanon Systems	Czechia
University of Arizona	USA	Varroc Lighting Systems	Czechia
University of Bari Aldo Moro, Dep. of Chemistry	Italy	Tenneco	Poland
Federal Inst. for Materials Research and Testing	Germany	Cooper Standard	Czechia
Ocean University of China	China	Mann+Hummel	Czechia
Tokushima University	Japan	Robert Bosch	Czechia
Johannes Kepler University Linz	Austria	Plastics Cluster	Czechia
University of Malaga	Spain	One3D	Czechia
Brno University of Technology	Czechia	Czech Academy of Sciences	Czechia
Masaryk University	Czechia	Pasteur Institute	France
HILASE	Czechia	Karolinska Institutet	Sweden
		Elettra Sincrotrone Trieste	Italy
		Medical University of Vienna	Austria
		Brno University of Technology	Czechia
		Masaryk University	Czechia





ABOUT CEITEC

CEITEC (the Central European Institute of Technology) is a unique research centre focusing primarily on the fields of life sciences, advanced materials, nanotechnologies and cybernetics. Since its establishment in 2011, CEITEC has quickly developed into a cutting-edge infrastructure for research, and performs highly alongside the best institutes in Europe. Among the main priorities of CEITEC are the promotion of a motivating and dynamic international scientific environment, the provision of state-of-the-art research infrastructure, and the policy of open communication and equal opportunities.

Basic Overview

25,000 m²
Laboratories

62
Research Groups

12
Core Facilities

1,437 employees
(511 on CEITEC BUT)

44 countries
(27 on CEITEC BUT)

Organizational Units



Brno University
of Technology



Masaryk
University



Mendel Univer-
sity in Brno



Institute of
Physics of Ma-
terials AS CR



Veterinary Re-
search Institute



University of Veterinary
and Pharmaceutical
Sciences Brno

CEITEC BUT



**Industrial Cybernetics, Instrumen-
tation and Systems Integration**



**Advanced Nanotechnolo-
gies and Microtechnologies**



Advanced Materials

CEITEC Nano

CEITEC Nano is one of the 12 core facilities. CEITEC Nano Research Infrastructure provides complex equipment, expertise and methods for nanotechnology and advanced materials for R&D.

70+
Instruments

**2,000 m² of clean-
room area**

**20+ number of
expert stuff**

**300+ of users per
year**

**70,000 instrument
hours per year**

All statistics are taken from the internal statistics of CEITEC, actual data from 2020.

WE BELONG TO
B R N O R E G I O N



#BRNOREGION

#brnoregion is a project that we are part of. It helps to promote the South Moravian Region and the city of Brno to the whole world, depicting it as the right address for innovation business, research, and development.

Full of Educated and International People

95.8% of #brnoregion inhabitants aged 30 to 34 are high school, college or university graduates

About **1.2** million people living in #brnoregion

Region for students

Brno was ranked **6th** most popular student city in the world. Mainly thanks to its high concentration of students

BUT is the **largest** technical university in the Czech Republic

Every **5th** person in Brno is a student

Expat-Friendly

21% students in #brnoregion are foreigners **60%** of them study at the faculties of science and technology

Expats considers the Czech Republic **3rd** best place in the world in terms of family life

50,000+ foreigners

Full of R&D

431 companies with their own R&D with **22,000** R&D people employed

16.5 billion CZK total expenses in 2018

12,000+ researchers **22,000** employees

GLOBAL DISCOVERIES FROM #BRNOREGION

MENDEL'S LAWS
OF INHERITANCE



LEGENDARY Z - VEHICLE



KAPLAN TURBINE



BREN MACHINE GUN

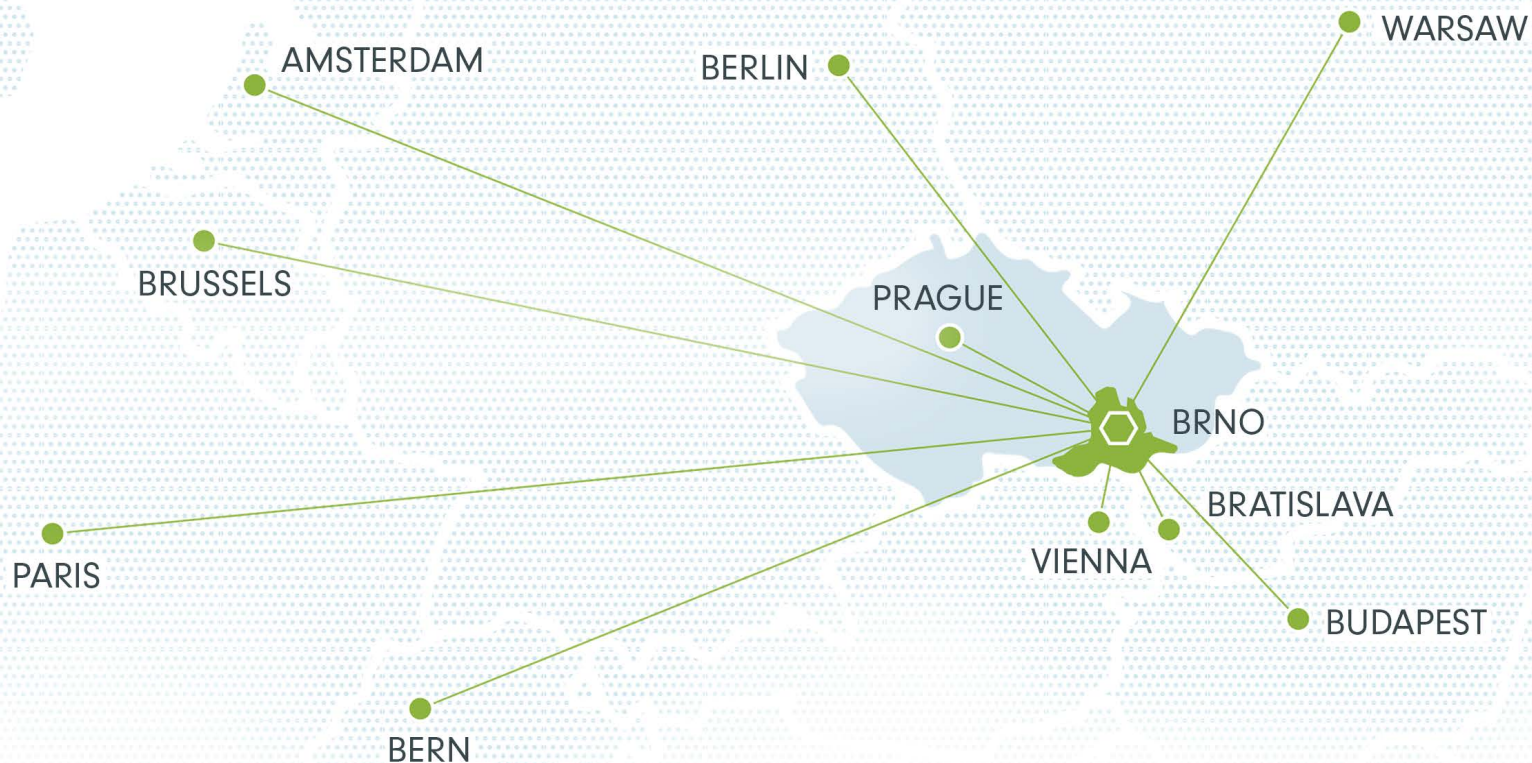


REMINGTON Z
TYPEWRITER



TESLA BS 242 TABLE TOP TRANSMISSION
ELECTRON MICROSCOPE





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Contact Research Group Advanced Instrumentation and Methods for Materials Characterization

Research Group Leader

Prof. Jozef Kaiser, Ph.D.

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