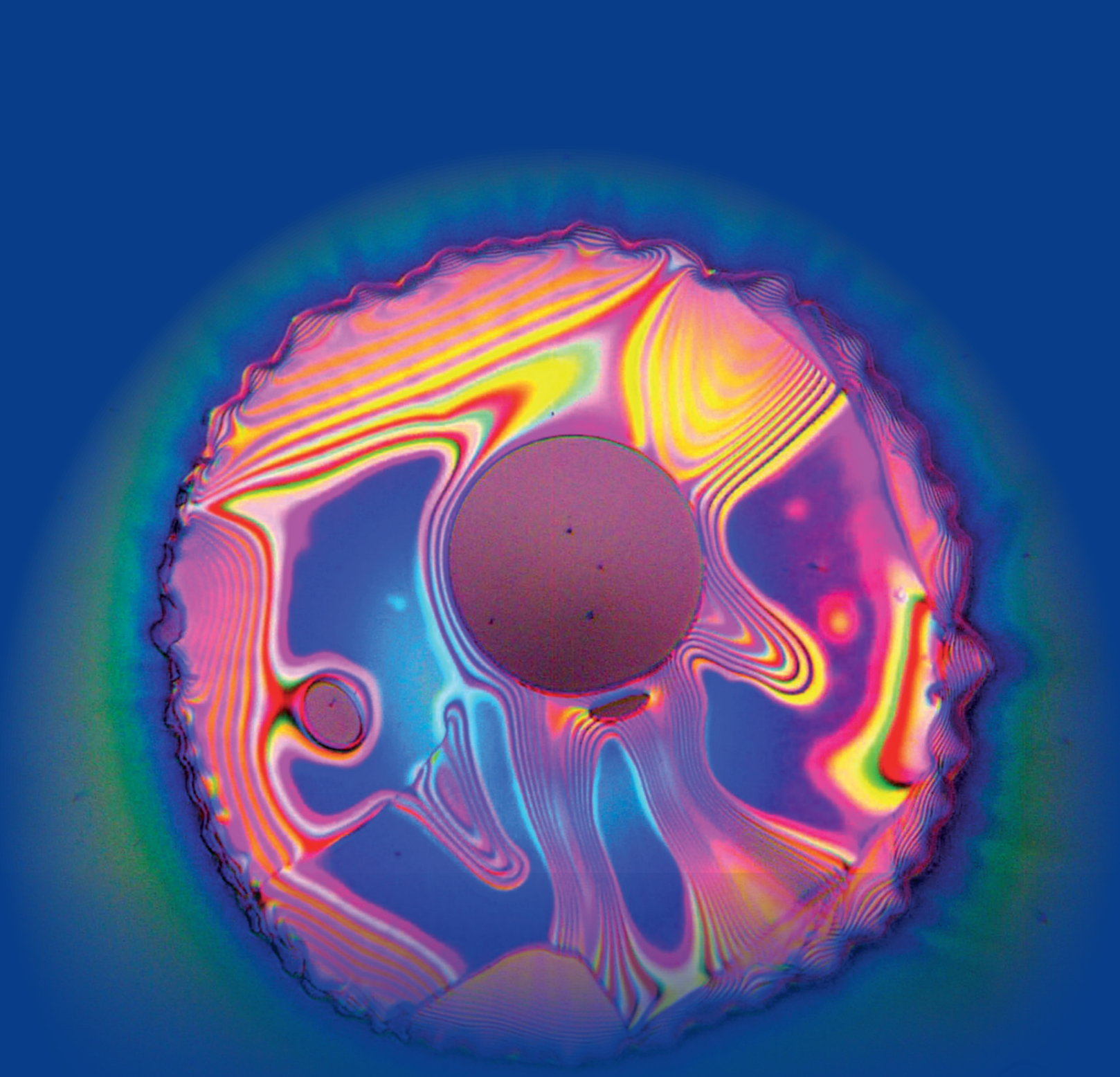

LASER TECHNOLOGIES IN LITHUANIA
2017

Publication initiated and published by the
Lithuanian Laser Association

LIETUVOS LAZERIŲ ASOCIACIJA LITHUANIAN LASER ASSOCIATION

Members of the Association: Vilnius University, Center for Physical Sciences and Technology, Altechna, Brolis Semiconductors, Direct Machining Control, Eksma, Eksma Optics, Ekspla, ELAS, Femtika, Holtida, Integrated Optics, Lidaris, Light Conversion, Optida, Optogama, Optonas, Optronika, Quantum Light Instruments, Standa, Sprana, Teravil, Workshop of Photonics.

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The publication also features material from the photo archive by the members of the Lithuanian Laser Association.

On the cover:

Laser-induced damage of dielectric high-reflectivity mirror coating recorded by differential interference contrast microscopy (image: courtesy of Lidaris). The damage diameter is ~650 µm.

LASER TECHNOLOGIES IN LITHUANIA 2017

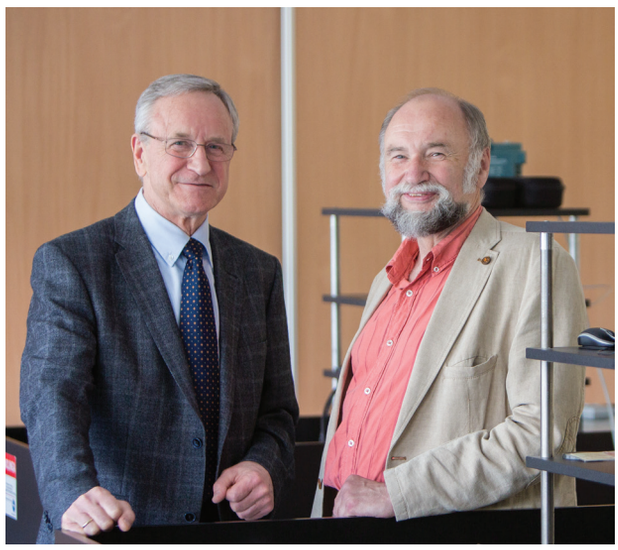
Fourth revised edition

LIETUVOS LAZERIŲ ASOCIACIJA

LITHUANIAN LASER ASSOCIATION

Vilnius, 2017

CONTENT



Prof. Dr. Algis Petras Piskarskas, President of the Lithuanian Laser Association
and Dr. Petras Balkevičius Executive Director of the Lithuanian Laser Association

Lithuania, with an impressive track record in laser manufacturing and innovative academic laser science, is a world leader in laser technologies. The strong cohesion between R&D activities in laser companies and academic research centers enables Lithuania as a major-league player in global marketplace. Scientific research started in academia has resulted in an impressive number of scientific breakthroughs and important commercial developments, such as OPCPA technology and TW femtosecond lasers that are currently pushing the frontiers of attosecond science.

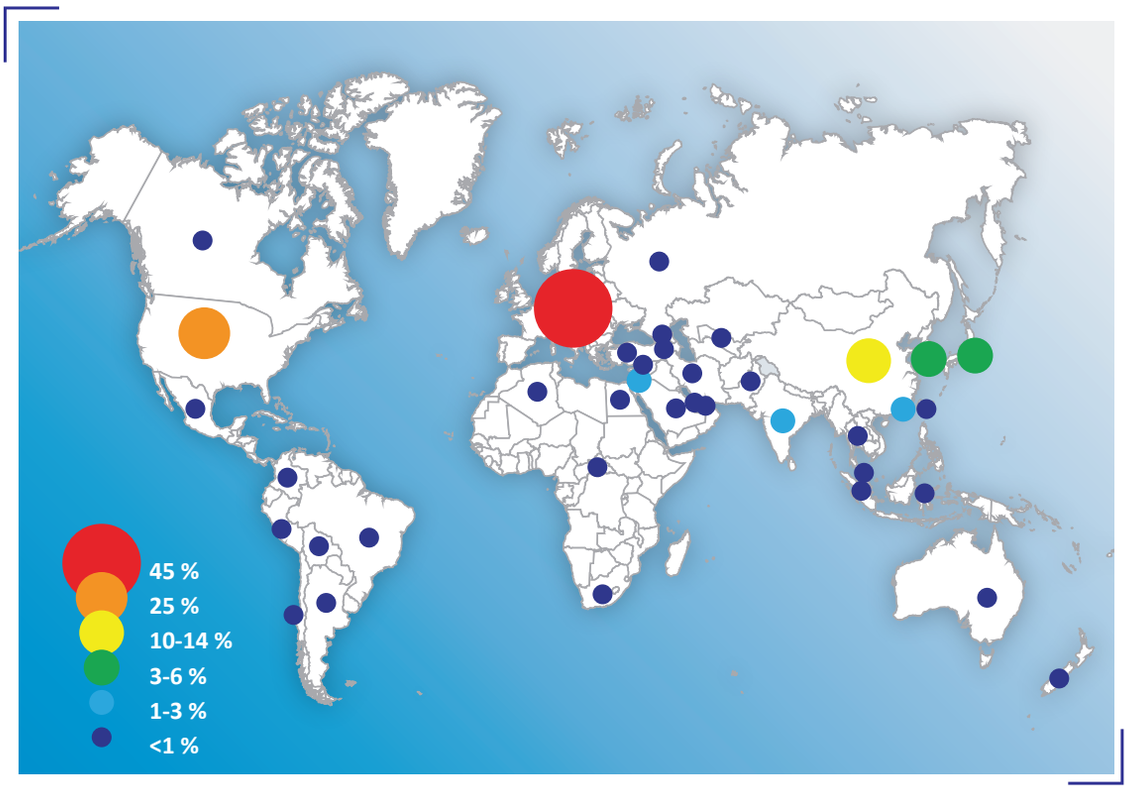
The output of Lithuanian laser industry covers a variety of fs/ps/ns tunable lasers, optical, electronic, mechanical laser components, assemblies, parts or different combinations thereof. Among the large number of customers there are European extreme light infrastructure centers as ELI-DC pillars in Hungary and Czech Republic, along with most of the best universities in the world (90 out of worlds' top 100).

Fundamental and applied research of laser physics in Lithuania began to sprout up more than five decades ago, i.e. not long after the first laser was created by US physicist Theodore Maiman in 1960. While developing this new direction of physics in Lithuania, tunable wavelength picosecond and femtosecond optical parametric amplifiers were created, original ultrafast spectroscopy methods and techniques were developed. Of particular importance has become an invention of Optical Parametric Chirped Pulse Amplification (OPCPA) technology at Vilnius University in 1992. Together with CPA technology, OPCPA opens revolutionary possibilities to boost laser light to extreme intensities that were deemed to be impossible.

The last five years have been truly impressive for the industry. The sales of the sector have grown nearly twice – from EUR 46,5 million in 2011 to over EUR 90 million in 2016. The major part of production, over 90%, is exported. Ten years ago, laser sector consisted of 10 companies, whereas in 2017 the count exceeded 30, employing over 800 people, among which almost 10% have PhD degrees. Although the entire industry was previously focused on the scientific laser niche, rapidly growing activities in laser material processing and improvements in laser technology allowed Lithuanian laser products to enter the industrial market, where nearly a half of total sales is currently taking place. Lithuanian laser products have even secured a reputation to warrant the applications by space exploration agencies.

In Lithuania, laser technology is among the four prioritized smart specializations of H2020. Following an official invitation, Lithuania is in a preparatory stage to become a member of ELI-DC AISBL. Recently Vilnius University Laser Research Center, which is a member of Laserlab-Europe, has developed 4 TW 1 kHz fs laser system "Naglis" which is a feasible platform for experiments on attosecond science and simulation of anticipated ELI-related systems at front-end level. Initial training and teaching of ELI personnel is also mutually beneficial.

By founding distributor companies abroad, the industry seeks to strengthen their positions in the global market. Lithuanian enterprises have a broad network of distributors and representatives over the world, as well as permanent presence at international exhibitions. We invite companies from across the world to integrate our laser products in their technologies and services.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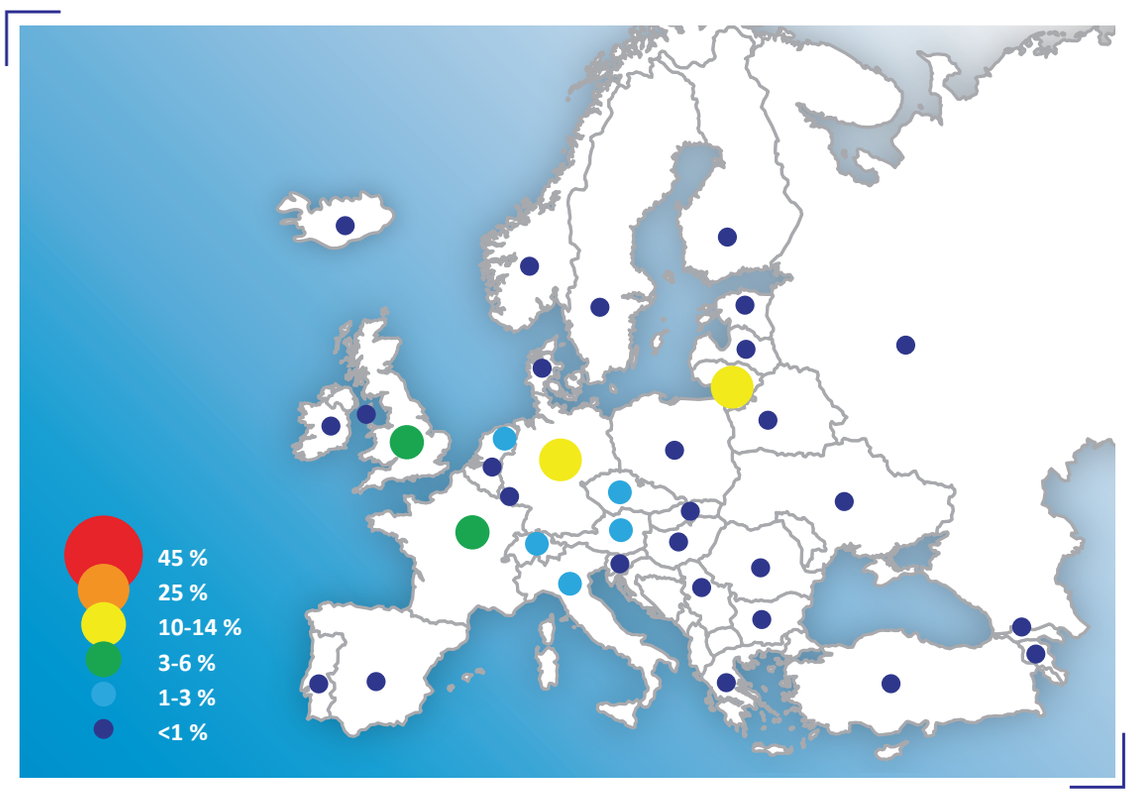
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One of the key factors in success of Lithuanian laser industry is the tight collaboration of researchers in scientific institutions and engineers in laser companies. It gives rise to a dynamic and constantly expanding laser ecosystem.

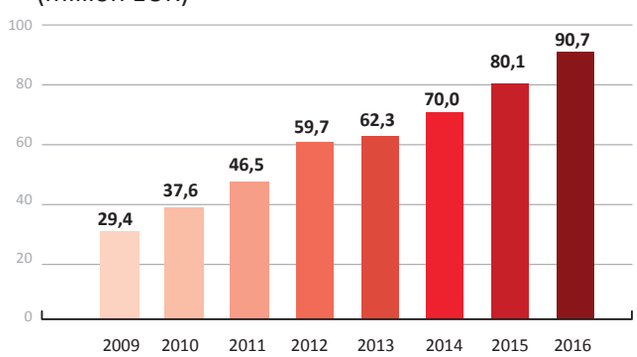
The products of Lithuanian laser sector are extremely diverse. It involves different lasers, optical, electronic, mechanical laser components, assemblies, parts or combinations thereof.

Lithuanian laser sector started more than 30 years ago and was initially focused on the scientific laser niche. In the past decade, it has made a concerted effort to gain a foothold in the industrial laser market, a market that exceeds that of the scientific lasers by an order of magnitude (Laser Focus World, January 2017, Annual Laser Market Review & Forecast). Efforts are bearing fruit: in 2016, nearly the half of all sales took place in this industrial market. However, fundamental research market remains important: laser products from Lithuania are in a great request by 90 out of 100 top universities in the world (QS ranking).

All the pioneering Lithuanian laser companies and most of the recently founded ones have been established by private initiatives, without foreign investment or direct government support. Initially, they only tapped the scientific potential accumulated within the country, whereas currently the collaboration ties have also been forged with foreign universities. In the quarter century of Lithuania as an independent state, the national added value chain has developed: ideas of new products born in research labs propagate through the manufacturing chain all the way to the wide network of distributor and service branches all over the globe.

In 2016, the sales volume of Lithuanian laser industry has reached EUR 90 million. The average yearly growth is more than 10 % a year. The projections show the same growth in the coming few years.

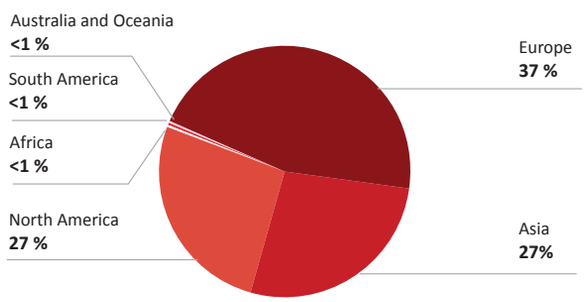
Growth in laser industry sales
(million EUR)



The export of Lithuanian laser industry is constantly above 80% of the total production volume; in 2016, the export of this sector exceeded 85%.

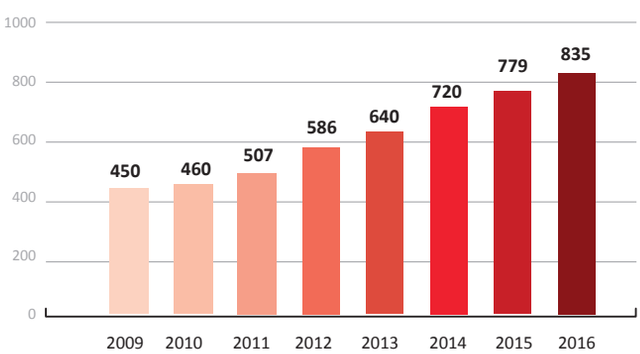
Lithuanian laser products are sold in all continents (except Antarctica) with nearly half of the sales taking place in Europe.

Export distribution by continent (%)

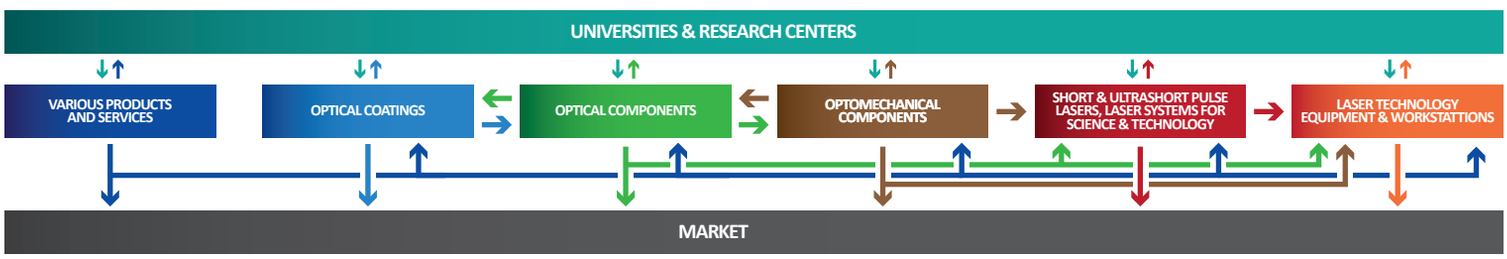


At the start of 2017, the laser industry of the country employed 835 people. Almost every tenth employee has a PhD degree.

Job growth




SHORT & ULTRASHORT PULSE LASERS LASER SYSTEMS FOR SCIENCE & TECHNOLOGY
OPTICAL COMPONENTS
OPTOMECHANICAL COMPONENTS
LASER TECHNOLOGY EQUIPMENT & WORKSTATIONS
OPTICAL COATINGS
VARIOUS PRODUCTS AND SERVICES
EKSPLA Scientific lasers & systems, industrial lasers, laser spectroscopy, opto-electronics, ultrafast fiber lasers
LIGHT CONVERSION Femtosecond & picosecond optical parametric amplifiers & generators, femtosecond lasers
INTEGRATED OPTICS Ultra-compact CW & pulsed diode & DPSS lasers & wavelengths combiners
OPTOGAMA "Eye-safe" lasers and optical systems
QUANTUM LIGHT INSTRUMENTS DPSS lasers for advanced OEM applications
EKSMA OPTICS Optical components & systems, nonlinear & laser crystals, pockels cells & drivers
ALTECHNA Laser related optical components, standard & custom optics, laser & nonlinear crystals, laser accessories. Complex custom solutions
OPTOTEKA Optical components & services
STANDA Opto-mechanical products, vacuum compatible products, optics, lasers & measure-ment ins-truments
LIFODAS Fiber optics equipment & accessories
AŠTUONETAS Laser engraving, marking, fine welding & cutting services
BROLIS SEMICONDUCTORS Infrared laser diodes and electro-optic systems for research, medical and defense
ORIENTAL TECHNOLOGY SOLUTIONS Laser equipment for marking, cutting & welding
GEOLA DIGITAL Photomaterials & lasers for holography
OPTRONIKA Lasers & accessories for laser show
DIRECT MACHINING CONTROL Software for laser machines
LIDARIS Laser damage testing services
TERAVIL Terahertz range spectrometers, emiters, detectors & accessories
LUVITERA Terahertz imaging, spectroscopy & microbolometers
SPRANA UV-VIS-NIR process analysers
ATO ID Plasmonic sensors for diagnostics
INTE-GRATED FIBER OPTICS Integrated fiber optics components
HOLTIDA Holo-graphic labels for anti-coun-terfeiting applications
OPTONAS Optical coatings
OPTINĖS DANGOS Optical coatings
OPTIDA Optical coatings
FEMTIKA 3D hybrid micro-fabrication technologies
EVANA TECHNOLOGIES Laser systems for technology
ELAS Industrial and scientific workstations for mass & small batch production with short pulse solid state & fiber lasers
WORKSHOP OF PHOTONICS Laser microfabrication industrial applications
CENTER FOR PHYSICAL SCIENCES AND TECHNOLOGY
Department of Optoelectronics
Department of Laser Technologies
Department of Molecular Compound Physics
VILNIUS UNIVERSITY
Quantum Electronics Department & Laser Research Centre
Semiconductor Physics Department & Institute of Applied Research
VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
Research Laboratory of Vibroacoustics and Diagnostics
THE GENERAL JONAS ŽEMAITIS MILITARY ACADEMY OF LITHUANIA
The Department of Engineering Management
KAUNAS UNIVERSITY OF TECHNOLOGY
Institute of Materials Science
Department of Surface and Thin Film
Research Laboratory of Optical Technologies
Department of Production Engineering of the Faculty of Mechanical Engineering & Design
VYTAUTAS MAGNUS UNIVERSITY
Department of Physics of the Faculty of Natural Sciences
NATIONAL CANCER INSTITUTE
Laboratory of Biomedical Physics

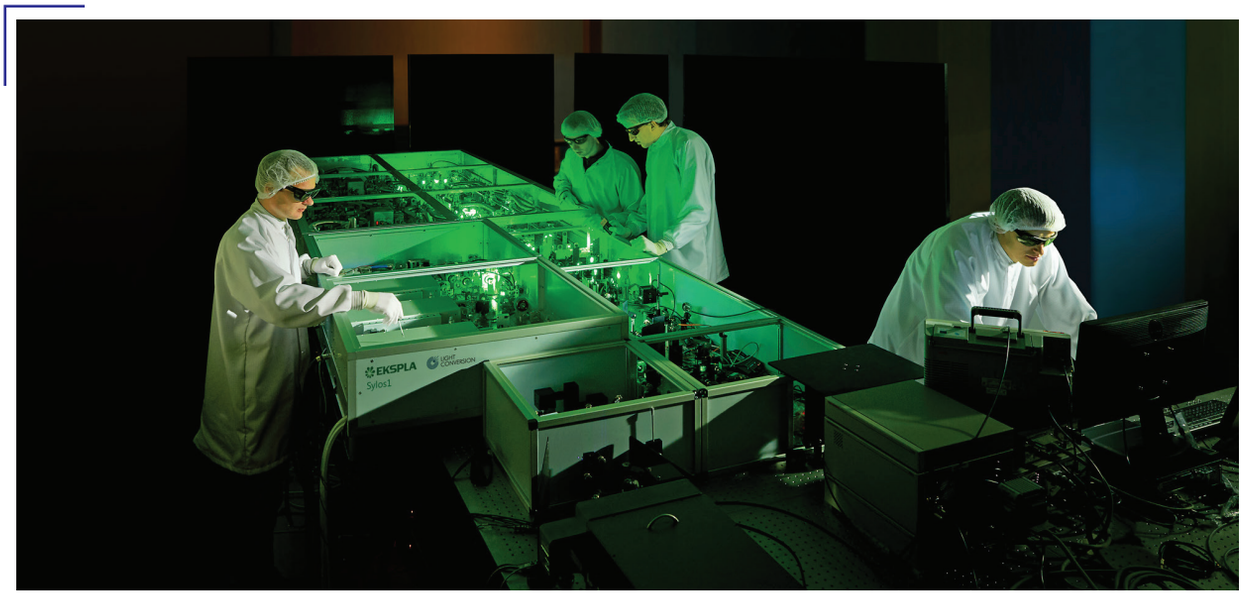

UNIVERSITIES & RESEARCH CENTERS
VARIOUS PRODUCTS AND SERVICES
OPTICAL COATINGS
OPTICAL COMPONENTS
OPTOMECHANICAL COMPONENTS
SHORT & ULTRASHORT PULSE LASERS, LASER SYSTEMS FOR SCIENCE & TECHNOLOGY
LASER TECHNOLOGY EQUIPMENT & WORKSTATTIONS
MARKET

Laser science and technology in Lithuania started its journey almost 50 years ago, just a few years after lasers were invented. Currently, lasers have become ubiquitous in a wide range of research and development areas, from laser physics and optical technologies, all the way to laser biomedicine.

The following R&D directions were pursued in the past decades:

1. Research of laser-matter interaction search for the new ways of generating coherent light using laser radiation.
2. Search for new materials to be modified and processed using lasers; applications of such materials in electronics, photovoltaics, photonics, biomedicine and automotive industry.
3. Research of active laser media and mode-locking techniques in order to generate picosecond and femtosecond laser pulses; development of new generation of lasers featuring high average power, high pulse energy, high pulse repetition rate. Development of solid-state and fiber lasers for science and industry.
4. Investigation of parametric light amplification phenomena in transparent media (including conical waves) and development of widely tunable laser sources. Generation of optical harmonics in high power laser systems.
5. Research of factors influencing resistance of optical materials to the damage induced by laser radiation; development of standardized diagnostics and characterization techniques for laser components.
6. Studies of interactions of ultrashort laser pulses with matter in order to develop efficient technologies for sub-micron (nanometer) scale material processing and programmable property control. These studies include the applications of femtosecond pulses for the fabrication of functional structures for photonics and medicine using two-photon photopolymerization technique, and laser micro-machining of materials.
7. Research of ultrafast energy transfer and relaxation processes in semiconductor structures and organic compounds; development of new methods and equipment for ultrafast spectroscopy.
8. Generation of microwave (terahertz) radiation in semiconductor structures using femtosecond laser excitation; development of new and efficient security and imaging technologies.
9. Development of new methods of medical diagnostics and therapy using cutting-edge laser technologies, including prevention and treatment of oncological diseases by photodynamic therapy and vision correction using femtosecond UV laser sources.

The list of Lithuanian scientific institutions involved in laser technologies and their brief descriptions are given in the Annex.

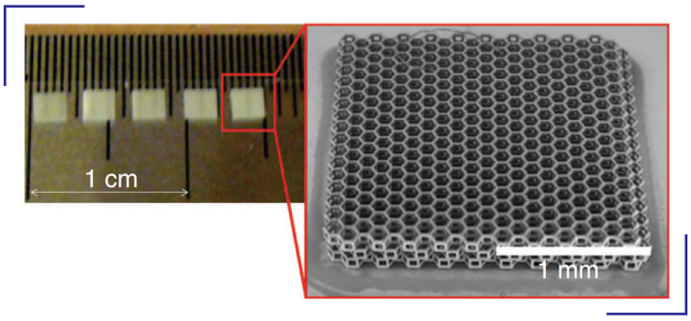


Two main players in laser-related research in Lithuania are Vilnius University Laser Research Centre and the Center for Physical Sciences and Technology (abbreviated FTMC in Lithuanian). They are accompanied by research labs of laser companies, who are becoming more and more versatile and capable. In the further sub-sections, the recent research highlights from all these institutions are presented.

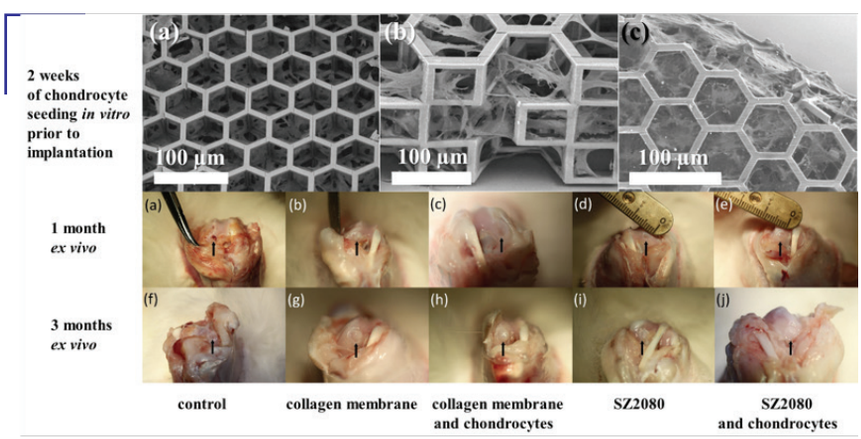
VILNIUS UNIVERSITY

Paving the way for laser companies to become suppliers of large scale laser facilities. The quest for higher laser pulse energies, more powerful and stable laser systems was always at the heart of the laser-related research performed at Vilnius University Laser Research Center. The latest development – high average power laser system Naglis was designed and built at the labs of Vilnius University over the period of 2005-2012. Its development harnessed optical chirped pulse amplification (OPCPA) technique – a brainchild of the scientists of Vilnius University. Building the laser system with unprecedented parameters was itself a formidable task, with no less than 5 PhD theses defended on the subjects of operating and managing the highest laser powers achievable using table-top systems. However, the results of the project reach far beyond the academic interest: Naglis became the prototype of the SYLOS laser system produced jointly by two Lithuanian laser companies, Ekspla and Light Conversion, for ELI-ALPS. The graduates of Vilnius University, now working at Light Conversion and Ekspla used the skills and techniques developed during their graduate work to produce this 'big brother' of Naglis. In the meantime, the 'little brother' has become a workhorse used for moderate-to-high energy experiments in laser physics at Vilnius University.

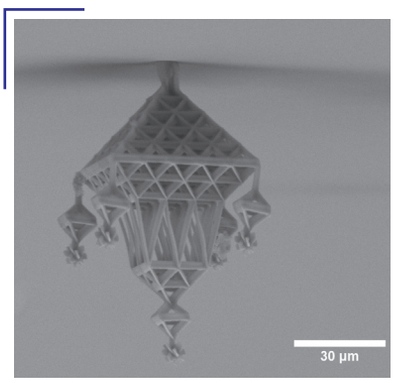
Building bridges between laser physics, medicine and nanotechnology. Nanophotonics Lab at Vilnius University Laser Research Center is researching artificial biomimetic scaffolds for cell growth. These microarchitectured structures are produced using direct laser writing (DLW) technology based on multi-photon polymerization (MPP). They are designed to become the habitats for cell cultures. By changing the structure of the scaffold, which is easily allowed by DLW-MPP technique, optimal conditions for different types of cells can be created. Such engineered tissues made of bio-polymer and recipient cells could then be used in the manufacturing of individually adapted prosthetic devices, such as replacement joints, heart valves, stents, etc. The tricky part is not only making the scaffolds, where the required type of cells could preferentially be cultivated, but also finding bio-compatible and biodegradable photopolymers that would harmlessly dissolve in the recipient's body without adverse effects. Vilnius University group led by Dr. Mangirdas Malinauskas was the first to demonstrate that artificial cartilage tissues, grown on the scaffolds produced by DLW 3D lithography, can be used for pre-clinical tests in vivo. In many cases, the response of test animals to the cell pre-grown artificial tissue was better than to the standard collagen-based cartilage replacements. Another advantage over collagen is the fact that mechanical properties of such tissues can be varied tuning the material, microarchitecture and filling ratio of the structure in significantly greater range - from elastic to bone-hard.



Scaffolds for cell growth produced using direct laser writing technique out of hybrid organic-inorganic polymer SZ2080.



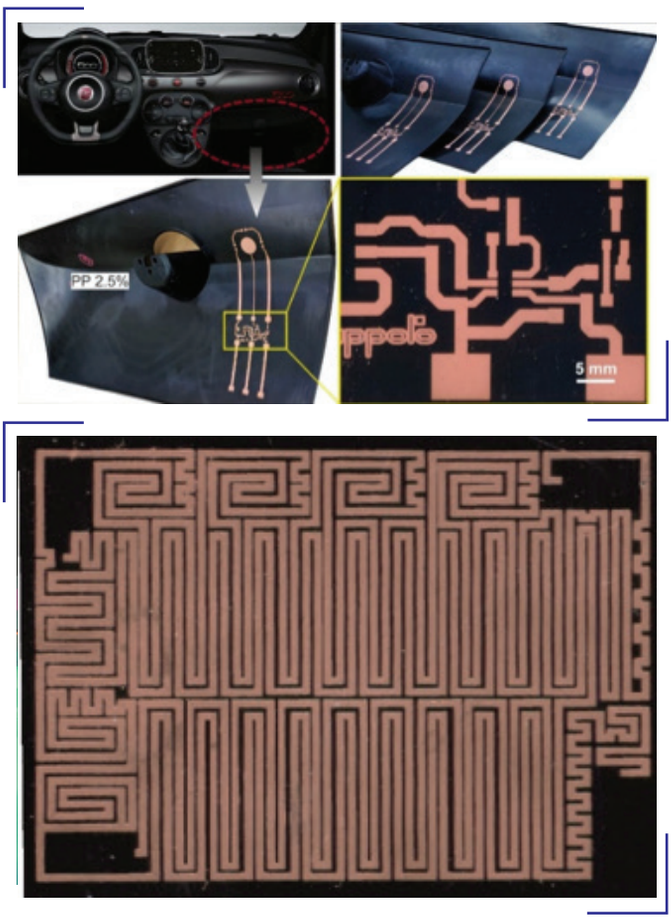
In vivo tests of implanted artificial tissues based on cell laden microstructured scaffolds.



Microstructures produced by direct laser writing

CENTER FOR PHYSICAL SCIENCES AND TECHNOLOGY

New technologies for laser-induced electroless copper plating for MID. Molded interconnect devices (MID) offer the material, weight and cost saving by integration electronic circuits directly into polymeric components used in automotive and consumer products. A new technology for the production of circuit traces, called Selective Surface Activation Induced by Laser (SSAIL) was developed at the Center for Physical Sciences and Technology (FTMC) during the implementation of FP7 APPOLO project. This new technique for selective surface plating can be applied to conventional plastics without any special additives, reducing material cost up to 3.5 times. This reduces the processing cost at least three times compared to the current technologies used in the electronics industry. SSAIL is a 3-step process. The first step is surface modification by laser, second – chemical activation of modified areas and the last step is metal deposition by electroless plating. This new technology has very high laser writing speed (up to 4 m/s). Therefore, spatial plating pitch is kept narrow as 25 µm. This new technique reduces the production cost of circuit traces for MID.50 % of all laser-related R&D funding in Lithuania.



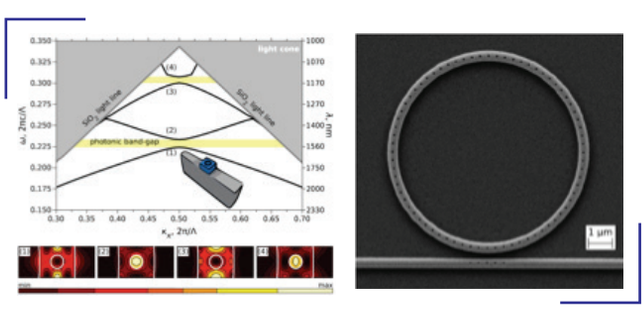
Conductive tracks for a glovebox cover touch button demonstrator, using polypropylene doped with multiwall carbon nanotubes.

Optimization of laser induced damage threshold (LIDT) in chirped mirrors. The main limiting factor for higher LIDT values is the intrinsic damage threshold high refractive index (H) material and/or H-L layer interface. Optimization by redistribution of electric field in chirped mirror coatings can lead to increased resistance to laser irradiation by at least a factor of 2. Further layer design optimization of electric field by reallocating electric field maxima on low refractive index (L) material layers is, most likely, possible as damage occurred only on H layers. Suggested CM design improvement could increase the reliability and LIDT performance of both CM elements and high power laser systems they are used in.

Pulse multiplexing and beam combining of four pulsed Yb-doped fiber lasers by non-collinear frequency up-conversion in an LBO crystal was demonstrated experimentally. An overall conversion efficiency of 51% and up to 29 W average power in a combined 532 nm beam were achieved. These results correspond to an improvement by a factor of 2 compared to the average power extracted from a single fiber amplifier. The second-order nonlinear interaction is a process without quantum defect, so the only channel for heat deposition is absorption, which is very low for LBO crystals, permiting upscaling the method to multi kW range.

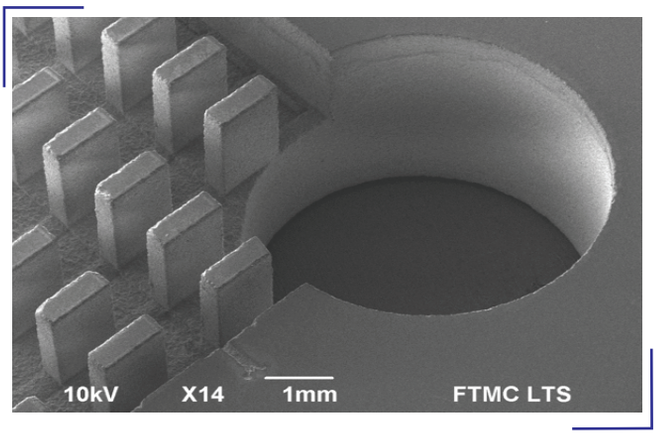
Compact femtosecond tunable optical parametric chirped pulse amplification (OPCPA) system with a picosecond all-in-fiber seed laser and a picosecond DPSS pump laser was developed. A novel OPCPA front-end was constructed using a multi-channel picosecond all-in-fiber source for seeding DPSS pump laser and white light supercontinuum generation. Broadband chirped pulses were parametrically amplified up to 1 mJ energy and compressed to less than 40 fs duration. Pulse wavelength tunability in the range from 680 nm to 930 nm was experimentally demonstrated.

Microring resonator with an integrated one-dimensional photonic crystal on a silicon-on-insulator platform was designed and fabricated with its applicability in bulk refractive index sensing. The photonic crystal was formed by periodically patterned, partially etched cylindrical perforations. The microring operates in both air and dielectric bands, and higher field localization inside the perforations for the air band mode leads to an increase in sensitivity.

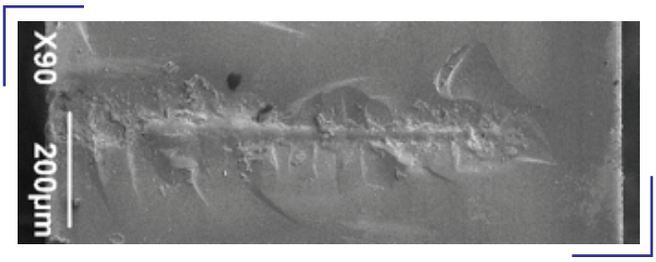


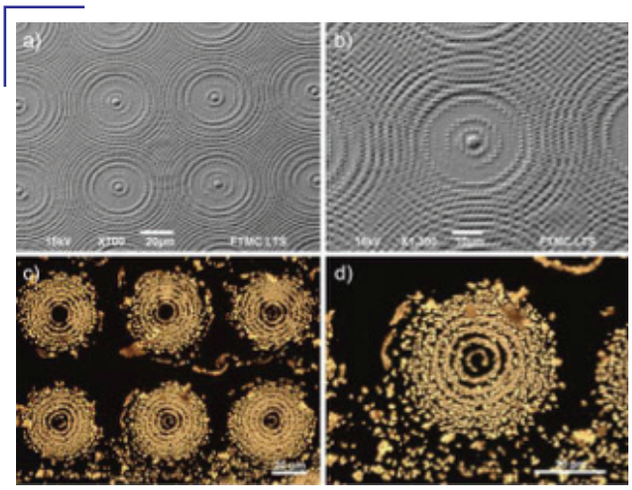
RFID antena fabricated on undoped ABS

Laser cutting of glass with asymmetrical Bessel beam. Conventional processing tools of glass are facing serious challenges in terms of processing speed and quality. While most of the modern laser processing is dedicated for thin, especially chemically strengthened glass, there is still a need for a suitable processing technique for thick glasses. One of the most material-efficient and energy-efficient glass cutting techniques is to locally weaken the material along the cutting path by generating cracks or material modifications and then separate sheets by applying thermal or mechanical load. Bessel beams have very appealing properties for the processing of transparent materials, such as the long non-diffractive propagation length and self-reconstruction. We have demonstrated the possibility to cut glasses up to 5 mm thickness by applying Bessel beam induced modifications. The cutting process offer high cutting efficiency.

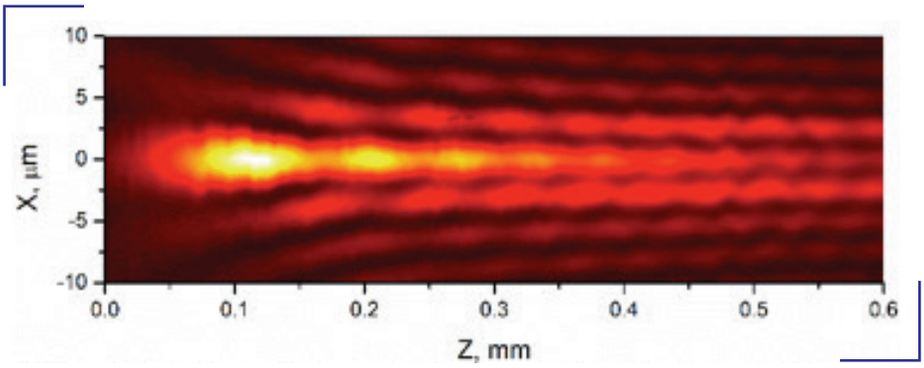


Electron micrographo of microstructure machined in glass using lasers





Gold nanoparticles arranged in concentric arrays using Bessel beams of light.



Intensity distribution in the XZ plane of the Bessel beam and cleaved glass sample with laser-induced single-shot modification.

Building lasers for frontier science. ELI is a European Union funded project for creating centers of advanced laser technology, which are beyond financial power of individual universities or research institutions. EKSPLA is participating in two ELI projects, namely in ELI-Beamlines and ELI-ALPS.

ELI-Beamlines project is anticipating creation of four laser systems and infrastructure for research in field of plasma physics. Two Terawatt class systems are designed and build by Czech scientists, one Petawatt class laser system is delivered by Lawrence Livermore National Laboratory, and the fourth 10 Petawatt class system Beamlines-L4 build by consortium National Energetics and EKSPLA. The design of the system is based on Texas Petawatt (Texas University, Austin) system experience where two technologies make the foundation of the entire system. The first technique, first proposed by the scientists of Vilnius University, is optical parametric chirped pulse amplification (OPCPA) where femtosecond pulses are stretched in time and amplified while controlling the spectral width and signal contrast. The second technology is a well-known workhorse used in other laser systems. Light pulse amplification occurs in large aperture disc amplifiers pumped by flash lamps. The main difference of the Beamlines-L4 system from the other flash lamp pumped disc amplifiers is in innovative disc amplifier design allowing high (for such class of lasers) pulse repetition rate of 1 shot per minute.

EKSPLA's part of this project is the design and construction of pump lasers delivering temporally shaped pulses for the OPCPA stages, allowing the amplification of optical pulses with broad spectral bandwidth.

ELI-ALPS assumes creation of a center of ultrashort light sources accessible to the international scientific community user groups. Laser driven secondary sources emitting coherent extreme-ultraviolet (XUV) and X-ray radiation compressed to attosecond duration pulses is a major research initiative of the infrastructure. ELI-ALPS sources parameters will include

- Few-cycle pulses, from the terahertz/infrared up to the petahertz/ultraviolet, with impressive 10 Hz to 100 kHz repetition rates;
- Attosecond extreme-ultraviolet, soft and hard x-ray mJ pulses with a 10 Hz - 100 kHz repetition rates;
- Sub-femtosecond hard x-ray pulses upto 10 keV photon energy and controlled ultra-relativistic pulse shapes with ultra-high contrast with 1Hz repetition rate;
- Controlled ultra-relativistic pulse shapes with ultra- high contrast at a few Hz repetition rate;
- Precise synchronization of the above light sources.

EKSPLA and Light Conversion are building a terawatt class laser for ELI-ALPS project system SYLOS operating at 1 kHz repetition rate and delivering light pulses of 10 femtoseconds. The system design is based entirely on OPCPA technology developed at Vilnius University Laser Research Centre. A femtosecond seed light pulse stretched in time is amplified in a cascade of parametric amplifiers. For this laser, EKSPLA is designing the pump source for the parametric amplifiers whereas Light Conversion manufactured the seed laser source of femtosecond pulses, high-energy optical parametric amplifiers, and the equipment controlling the pulse duration and bandwidth, and monitoring the output parameters.

As of 2016, the project is at its final stage. The operational system was presented to the customers at the manufacturer's facilities. The demonstrated parameters are the pulse duration of 9 fs, pulse energy 43 mJ, the spectrum centered at 820 nm and carrier-envelope phase stability of 240 mrad over 1 hour period. The pulse repetition rate is 1 kHz. After compressing the pulses to 9 fs in a vacuum compressor, the peak power of the pulses should reach 4.8 TW, which makes it the highest peak-power laser operating at 1 kHz repetition rate.

Productive negotiations with the customer in Hungary have been started about the additional contract on further expanding the capabilities of the system.

Glass-cutting technology for smartphone industry. Corning Incorporated (NYSE: GLW) and Workshop of Photonics have entered a Joint Development Agreement to work together on the development of new laser glass processing technologies. Michael Müller, Managing Director of Corning Laser Technologies, said 'the emerging opportunities for ultra-strong, ultrathin, and ultraclean glass processing solutions, along with a need for greater glass processing efficiencies, are driving the demand for laser processing technologies. We believe this strategic relationship with Workshop of Photonics will enhance our ability to deliver innovative laser processing solutions for glass.'

The patent pending technology for processing tempered glass and sapphire was developed by Workshop of Photonics. Success in smartphone industry and outpacing industry giants with the top-choice solution lead to implementing it to a hardware module that is successfully combined with femtosecond lasers in industrial applications. This prosperous agreement opens an access to the industry to overcome other existing challenges and become the desired partner in laser micromachining.

It is one of the most successful cases of intellectual property marketing of Lithuanian laser sector.

Vilnius University Laser Research Center (VULRC) has been a part of Laserlab-Europe since its inception in 2004. Laserlab-Europe is a network of European laser research infrastructures funded by the European Union. It brings together 33 leading organizations in laser-based inter-disciplinary research from 16 countries. Together, they foster collaboration and transfer of know-how and offer training for researchers. Joint research activities deal with the most important scientific challenges in laser research, enabling novel applications with high industrial and social impact. Research fields include biomedical and life science applications of lasers, innovative laser technologies, photonic techniques in materials science and high-intensity laser development. Laserlab-Europe is pushing the laser concepts into new directions and opening new application fields, both for the benefit of the European user community and for optical sciences and technologies as a whole.

Together with associate partners, Laserlab covers the majority of European member states. 22 facilities (including VULRC) offer access to their labs for research teams from Europe and beyond. The main objecticves of Laserlab-Europe are:

- To promote, in a coordinated way and on a European scale, the use of advanced lasers and laser-based technologies for research and innovation,
- To serve a cross-disciplinary user community, from academia as well as from industry, by providing transnational access to a comprehensive set of advanced laser research facilities, including two free-electron laser facilities, in a highly co-ordinated fashion,
- To increase the European basis of human resources in the field of lasers by training new users,
- To improve human and technical resources through technology exchange and sharing of expertise among laser experts and operators across Europe, and through coordinated Joint Research Activities enabling world-class research, innovations and applications beyond the present state-of-the-art.

The EU-funded transnational access program enables scientists to have hands-on access to the best laboratories for their research work, wherever they might be located. This opportunity now has also become open for groups of researchers working in universities or research institutions outside the EU.

Since the start of Laserlab-Europe, VULRC has given an access for more than 100 scientists (47 projects) from 14 EU countries. The main research topics on which VULRC offers transnational access are: ultrafast nonlinear optics, femtosecond filamentation in solids and liquids, spatio-temporal characterization of light wave packets, ultrafast pump-probe spectroscopy in wide spectral range, ultrafast terahertz time domain spectroscopy, ultrashort pulse interaction with matter, multiphoton polymerization and femtosecond micromachining, and research on laser-induced damage.

Map of Laserlab-Europe IV facilities

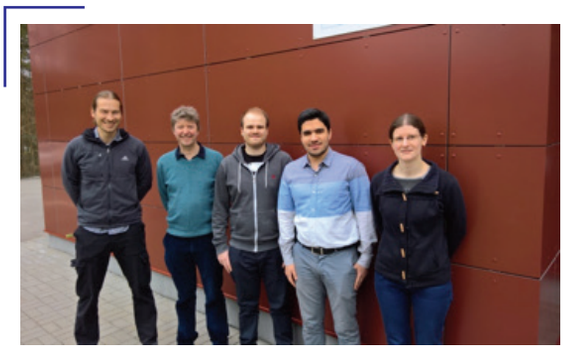
Transnational Access is provided by Laserlab-Europe Consortium

- to world-class laser research facilities,
- to a large variety of inter-disciplinary research, including life sciences,
- free of charge, including travel and accommodation.

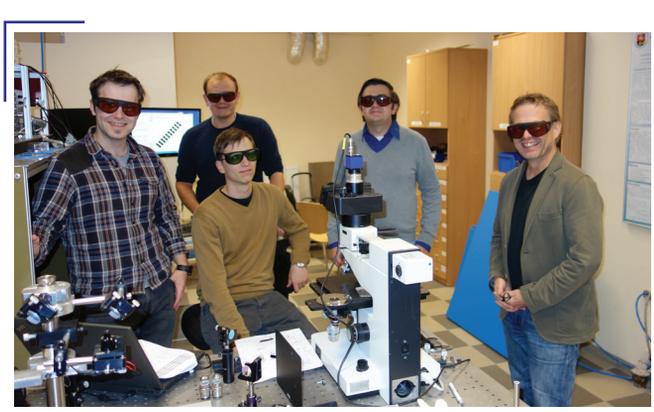
Access is granted on the basis of scientific excellence of research proposals, reviewed by an external and independent selection panel. Priority is given to new users.

If you would like to perform your own experiments at a Laserlab-Europe facilities, including VULRC, please see

www.laserlab-europe.eu.



Visiting scientists from University of Sheffield (United Kingdom) with colleagues from VULRC



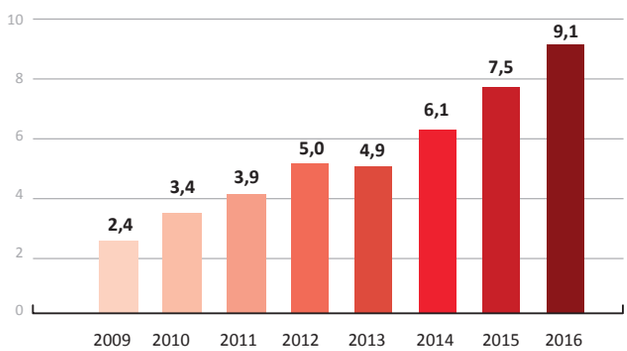
Visiting scientists from Braunschweig Technical University (Germany) with the researchers from VULRC

INVESTMENT IN R&D: COSTS AND RETURNS

Investment in R&D activities is the key factor determining the competitiveness of the products manufactured by the Lithuanian laser industry. Only the products in step with the cutting-edge developments in laser science and technologies can succeed in the global market. Therefore, most of the Lithuanian laser companies invest at least 10 % of revenues in their research and development infrastructure, participation in scientific projects and development of new innovative products.

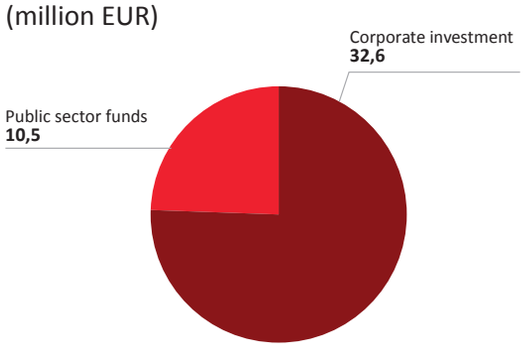
Investments in R&D of Lithuanian laser companies have been consistently growing in the recent years; in 2012-2016, annual investment volume has have passed EUR 9 million mark. This is approximately twice the annual R&D investments made in the period of 2009-2012. The overall amount invested by the companies in R&D over the past five years is more than EUR 32 million.

Laser sector companies investment R&D (million EUR)



In the recent years, laser companies have been more actively using public funds available for R&D investments via different EU programs, Lithuanian Structural Funds, programs administered by Lithuanian agencies MITA (Agency for Science, Innovation and Technology), and LVPA (Lithuanian Business Support Agency). In 2012-2016, the companies have secured more than EUR 10 million of public funds, which accounted a quarter of the total company investments in R&D.

Sources of investment in R&D in 2012-2016 (million EUR)



The main part of investments was allocated for R&D infrastructure development. *Light Conversion, Ekspla, Optolita, Optida, Altechna,* and *Brolis Semiconductors* are all carrying out large scale projects to expand their labs and industrial premises, setting up cleanrooms required for new technologies being developed.

High priority is placed on the acquisition of the newest diagnostic instruments, equipment for technological processes and production. The remaining part of investments is used for funding in-house research work, research on demand and public programs.

Analysis of the return on investment clearly shows that the country regains invested funds rapidly and with a large profit margin to boot. There is no doubt that investment in R&D has made significant contribution to the fast growth of industrial output and created new jobs. The projections for 2014-2020 place the volume of company investments in R&D at respectable EUR 70 million.

INVESTMENT IN PARTNERSHIPS BETWEEN RESEARCH INSTITUTIONS AND INDUSTRY

Investment in laser science and research of optical technologies is vitally important for the successful development of the Lithuanian laser industry. Projects in applied research are usually intended for the development of innovative laser equipment and the improvements of current products.

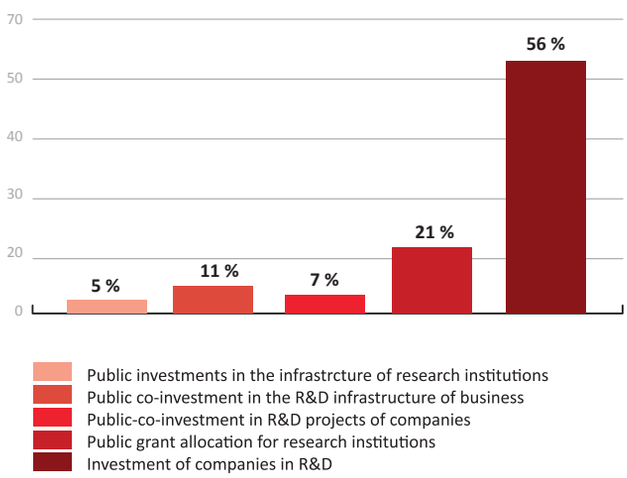
Fundamental research in laser science is equally important (and remains an imperative necessity). The research provides better understanding of physical processes important in the operation of lasers and nonlinear optical devices. It often stimulates the birth of qualitatively new commercial products and allows finding new applications for laser equipment. Finally, it provides the high-level training for the young people who later join the companies with their knowledge, ideas and skills.

The major part of research in these areas is carried out at the Laser Research Center of Vilnius University, and the Center for Physical Sciences and Technology. However, as research infrastructure builds up at the laser companies, and the number of employees with PhD degrees increases, the amount of research performed at the companies is also growing.

Investment in R&D of lasers and optical technologies is used for developing scientific and technological infrastructure, funding specific projects in applied and fundamental research, acquiring services from other industrial companies.

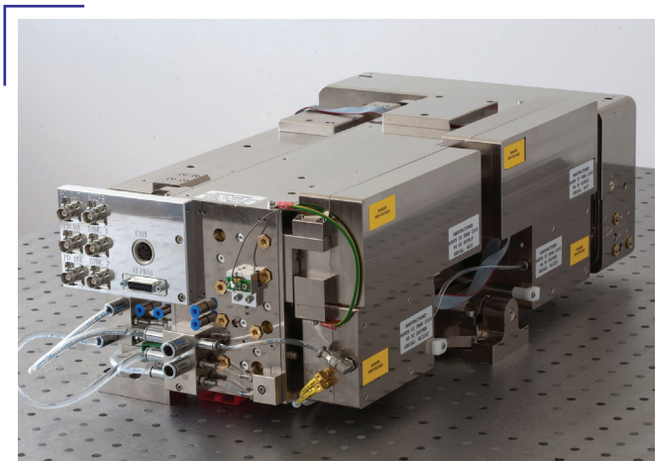
In 2012-2016, the total amount of investment in R&D projects and research infrastructure of scientific institutions and laser companies has been almost EUR 60 million. It must be noted, that investments of companies in R&D accounts for more than 50 % of all laser-related R&D funding in Lithuania.

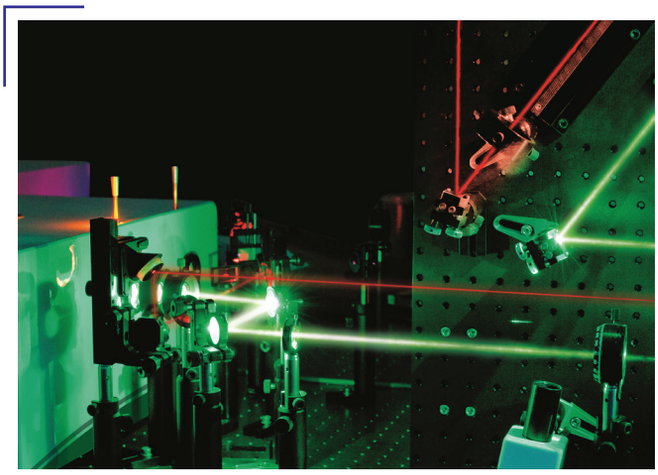
Investments in Laser Science and Technologies by Source of Funding in 2012-2016 (%)



R&D projects carried out in collaboration between scientific institutions and companies are very important to Lithuanian laser community. In 2012-2016, more than 70 different R&D projects were underway, with more than EUR 11 million total funding. EUR 4,6 million, was received from EU programs FP 6, FP 7, EUROSTARS, EUREKA, Lithuanian foundations and agencies MITA, LMT (the Research Council of Lithuania), LVPA research support funds; the remaining EUR 6,4 million were allocated by laser businesses.

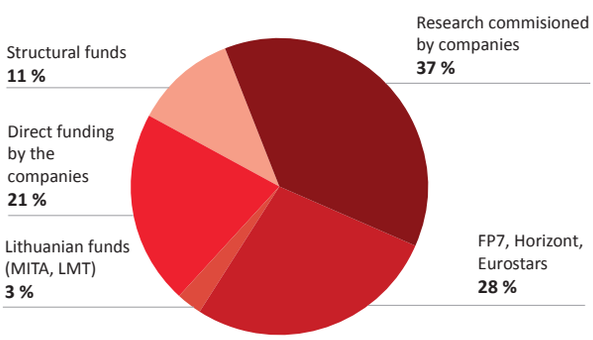
Intelektas LT, the program carried out by the Lithuanian Business Support Agency (LVPA) has opened a range of new possibilities of business-science collaboration. Making use of this program, Altechna, Ekspla and Light Conversion, ELAS, Sprana and Brolis Semiconductors have successfully completed or are underway with several large scale projects. They are dedicated to the development of multi-functional laser platforms, laser systems for the production of solar panels, optoelectronic devices for medical applications and lasers for ophthalmic surgery and life science. The total value of these collaborative projects is EUR 2.2 million.





Collaboration between laser businesses and foreign research institutions is growing. In 2012-2016, 9 Lithuanian laser companies were (or still are) the partners of 19 international projects of FP 7, EUROSTARS and Horizont 2020 programs. Project topics cover the development of novel laser sources, application of lasers and optical techniques in nanotechnologies, biomedical research, identification of explosives or pollutants, diagnostic systems and industrial processes. The Lithuanian funding share in these projects is over EUR 4 million.

Funding of joint projects in 2012-2016



The volume of research-on-demand of laser businesses performed by research institutions in 2012-2016 was around EUR 4 million. The annual volume of such services has grown more than four times compared to the period of 2009-2013. The typical tasks of such research include the development of specialized optical coatings, feasibility studies of different types of lasers and laser components, characterization of nonlinear optical devices; improvements of diagnostic equipment, laser applications in micromachining and micro-structuring, etc.

During 5 last years funding of collaborative projects by companies and EU funds increased by 1.5 times compared to 2009-2013 period, while the financial support from Lithuanian national agencies dropped by more than 4 times and covers only 14 % of the costs incurred in such project. While it may be tempting to write this off as 'technical difficulties with starting the distribution of EU funds', such lack of government attention to the development of science is borderline scandalous. Especially, it needs to be addressed with the view on the fact that the EU support will decline substantially after 2020, and a more proactive role is expected from the national science agencies.

Joint research projects are not the only form of collaboration, there are also joint workshops, exchange of research equipment, and the annual national conference Lasers: Science and Technologies (see further sections).

Lithuanian education system has been successfully training laser specialists for several decades. The science centers, where these young minds are sharpened, are known for their high competence and world-class laser research. A special place among them belongs to the Faculty of Physics of Vilnius University, where laser physicists have been studying and teaching for over 40 years.

The major in quantum electronics was first chosen by 10 freshmen in 1970 (the first laser-related research projects were performed by the students majoring in other fields already in 1971). Quantum electronics was made an official direction of research and studies in 1974, when the Department of Astronomy and Quantum Electronics was founded. In 1975, the first graduates in quantum electronics received their diplomas. In 1988, a separate Department of Quantum Electronics, now called Laser Research Centre, was formed, where laser physicists are being taught to this day. From 1975, the Laser Research Centre has graduated over 600 people in laser physics.

Currently, the Faculty of Physics offers courses on lasers starting from the bachelor level. Students can choose the subjects titled Laser Physics, Technological Applications of Lasers, Laser Technology, and Quantum Electronics.

Two master programs are dedicated to training laser specialists in Lithuania: Laser Physics and Optical Technologies, and Laser Technology. They are both managed by the Faculty of Physics. The goal of these programs is to train high level professionals able to develop and use modern laser technologies in practice. A new bachelor program “Light engineering” is currently under development. Its duration will be 3.5 years, and the students be taught the basic knowledge and practical skills required by Lithuanian laser industry and other photonic-related areas. The graduates will have a choice of joining the industry immediately after completing the program, or entering one of the master programs to further their education.

From 2007, a master program in optoelectronics is offered by Vilnius University, Faculty of Physics. The program is mainly oriented towards LED technologies and applications.

Students make use of modern teaching and research labs at Vilnius University Laser Research Center and Vilnius University Institute of Applied Research. They are encouraged to attend the workshops given by Lithuanian and foreign scientists, and the public defenses of PhD theses. The scientific quality of MSc graduation works is commendable: a significant fraction of graduates publish the results of their MSc works in peer-reviewed scientific journals.

PhD studies in laser physics are also available in Lithuania. Vilnius University Laser Research Center is home to a number of graduate students in physical and technological sciences. Laser-related PhD careers can also be pursued in other scientific centers in the country: divisions of Laser Technology and Optoelectronics at the Center for Physical Sciences and Technology, the Department of Mechanical Engineering at Vilnius Gediminas Technical University, the Institute of Material Science, the Institute of Mechatronics and the Department of Production Engineering at Kaunas Technical University.

All research centers are equipped with excellent research infrastructure, which has been funded by EU structural funds, High Technology Development Program, other international and national projects and – in some cases – by Lithuanian laser companies. Modern research equipment is used for practicums. The students participate in the international exchange programs opening access to the best research centers in the world, where their competences and training level is held in high regard.

Prof. Dr. Valdas Sirutkaitis, Prof. Dr. Mikas Vengris, Dr. Arūnas Varanavičius with students at the University of Vilnius teaching laser laboratory

Lithuanian representative Dr. G.Račiukaitis represnting EU laser science in EU-China meeting of laser industries organized by EPIC (2016)`.

A large number of graduates from Vilnius University and Lithuanian science institutes have found their places abroad in the world-famous laser laboratories. Many of them retain close ties with Lithuanian science and education institutions and laser companies. They give lectures and share experience visiting Vilnius University (VU) and the Center for Physical Sciences and Technology (FTMC), pursue joint development projects with laser companies and scientists using the projects of Eurostar and High Technology Development Projects, attend events held by the Lithuanian Laser Association.

The largest Lithuanian group working with high intensity ultrashort pulse lasers is headed by Prof. Andrius Baltuška at the Technical University of Vienna. This group currently hosts three Lithuanian researchers and three-four graduate students. Close collaboration ties are maintained with Lithuanian scientists and companies in the development of generators and amplifiers of femtosecond laser pulses in 2-6 μm wavelength range and researching the generation of attosecond pulses.

Another group worth mentioning is the group under the leadership of Prof. Kęstutis Staliūnas at the Polytechnic University of Catalonia (Barcelona), where two to three graduate students, MSc students or post-docs from Lithuania are working. Together with groups from VU, FTMC and Lithuanian laser companies, the group is pursuing research of the application of photonic crystals for spatial filtering of laser beams.

Prof. Almantas Galvanauskas from the University of Michigan has been advising FTMC scientists on the development of fiber lasers for about fiftien years; he invites scientists and graduate students from Lithuania to work in his scientific group.

Prof. Saulius Juodkazis from Swinburne University of Technology in Australia has been collaborating with Lithuanian laser scientists and laser companies for many years. His interests include the growth of new laser materials, technological research of ultrashort pulse lasers and their applications. Two or three graduate students, MSc students or post-docs from Lithuania are always a part of his team. He is also often enlisted by different Lithuanian projects as a consultant.

The list of Lithuanian laser scientists abroad maintaining close relationships with Lithuanian scientists and companies would be incomplete without Prof. Virginijus Barzda from the University of Toronto, Prof. Valdas Pašiškevičius from the Royal Institute of Technology in Stockholm, Dr. Rimas Juškaitis from the University of Oxford, Dr. Vygandas Mizeikis from Shizuoka University in Japan, Dr. Aleksandr Ovsianikov from Vienna University of Technology, Dr. Gediminas Jonušauskas from the 1st University of Bordeaux (France), Dr. Arvydas Ruseckas from St. Andrews University in Scotland, Dr. Donatas Zigmantas from Lund University (Sweden) and many others, whose experience and knowledge in different laser-related fields add significantly to the knowledge of Lithuanian scientists and businessmen.

Summer conferences bringing together Lithuanian laser community commenced in the last decade of the twentieth century. They have been held annually since 2009. In 2017, the thirteenth annual national conference “Lasers: science and technologies” will be organized. Each year, a number of Lithuanian laser physicists and engineer working abroad (see section Lithuanian Laser Diaspora) come and present their newest research results to Lithuanian laser community. The conference is not meant only for business: people bring their families for a social event in open air. It lasts the entire weekend with campfire songs still going strong at dawn.

The conference seems to have made a long-lasting impression of Carlos Lee, Director General EPIC - European Photonics Industry Consortium, who later wrote:

I recently presented at the 12th National Conference “Lasers: Science and Technology” and what I found most striking about this event that takes place every year on the last Friday of August is how it distinctively brings together the Lithuanian laser industry. The event was composed of a full day conference featuring an update from 20 local companies, and a panel discussion with the participation of the vice-minister of science and vice-minister of economy. The involvement of government representatives was respectable but not something unusual. What was unique about this event, and something that I have not come across anywhere else in the world, is the social aspect that brings together the entire Lithuanian laser industry. Social activities included a music concert, sauna, midnight swimming in the Bebrusai lake, songs by the Campfire (till very late in the night), numerous sports activities following morning including company team football matches… it was a complete festival! In total there were 300 employees of laser companies, 200 spouses, and 100 children. While individual companies frequently organize team-building events, I have never seen this on the scale of an industry at a national level. It was an honour and sincere pleasure to be part of it!

The scientific programme of the conference traditionally includes a number of talks presented by the members of Lithuanian laser diaspora (see previous section) representing the world’s strongest laser laboratories. Other presentations are made by the leading researchers of Lithuanian scientific institutions and chief R&D people from laser companies.


EKSMA
OPTICS
Elektrooptinių moduliatorių –
Pokelso celių gamyba
SAFYRO SKRAI
SiC SKRAIBAVIMAS

Industrial lasers

Due to their versatility and flexibility, lasers have become conventional production tools. The majority of industrial lasers in Lithuania and elsewhere are used for sheet metal cutting. They are typically powerful kilowatt systems, with powers up to 6 kW, able to cut through 20-30 mm metal sheets. In Lithuania, we count more than 60 such machines for sheet and pipe cutting. Fast, precise, and automated cutting and flexible process control have made such systems indispensable in metal processing industries. CO2 lasers that traditionally dominated this market are being superseded by more efficient fiber lasers.

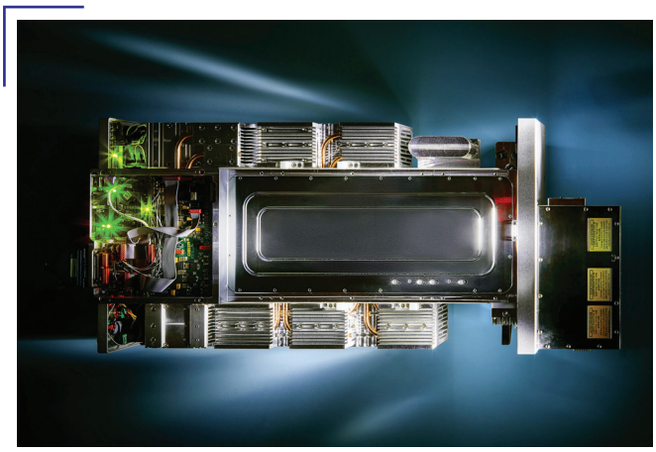
High performance lasers made in Lithuania a not intended for down-to-earth macro-processing market. Taking advantage of broad expertise in the fields of photonics, Lithuania has made an important step towards industrial laser technologies. Close collaboration of laser companies with research teams at Vilnius University and Center for Physical Sciences and Technology paved the way for the development of industrial laser technologies, mainly in micro and nano-processing, utilising the benefits of ultra-short laser pulses. The knowledge gathered in joint researched projects led to the qualitatively new results in the field. New kind of companies started to grow in Lithuania with the focus on commercial implementation of laser micromachining technologies. Workshop of Photonics and Evana Technologies are working in niche applications with emerging laser technologies for processing of transparent materials, glasses and sapphire. Femtika was established to capitalize on the expertise of researchers of Laser Research Center at Vilnius University in direct laser writing (3D printing) of photopolymers. A company ELAS is acting as system integrator building complex laser machines for industrial applications. Together the with Department of Laser Technologies of FTMC, they are successfully installing laser machines into the production lines at Precizika Metrology for the fabrication of advanced highly precise measurement devices.

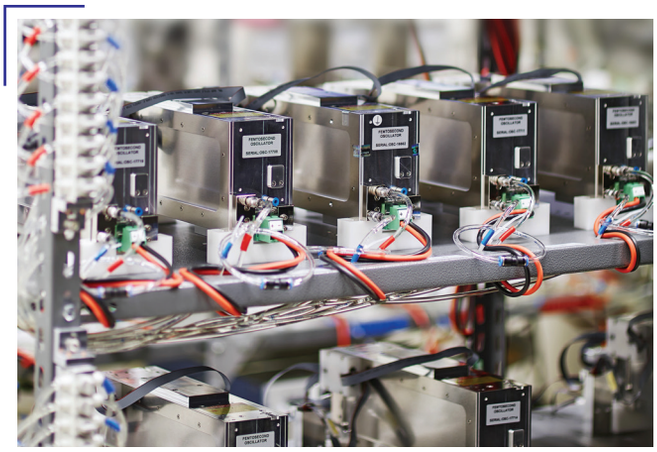
Visibility and trust on laser and laser technology development in Lithuania was significantly increased by FP7 project APPOLO (www.appolo-fp7.eu) coordinated by FTMC and involving ELAS and Ekspla among the 36 partner consortium for assessment of industrial laser technologies.

Optronika offers custom laser illumination and laser shows for different events and advertisements; they design and manufacture laser projectors and other laser-based illumination sources.

Laser systems at Lithuanian research institutions

In the past five years, Lithuanian research institutions have acquired laser systems for nearly EUR 3 million. A significant part of these systems (worth EUR 0.6 million) was designed and manufactured by Lithuanian companies: Ekspla, Light Conversion, Standa, Optida, Optolita, Altechna, ELAS, etc. Local manufacturers can quickly and flexibly provide equipment, components and services required for research, which is especially important for R&D projects carried out in collaboration with research institutions. The researchers, in turn, are the first source of feedback on newly developed technologies, their first ‘real world’ tests and potential applications. The omnipresence of lasers throughout the labs of universities and research institutes promotes Lithuania’s competitiveness in the international markets and projects the image of Lithuania as an advanced country with deep traditions in laser applications.

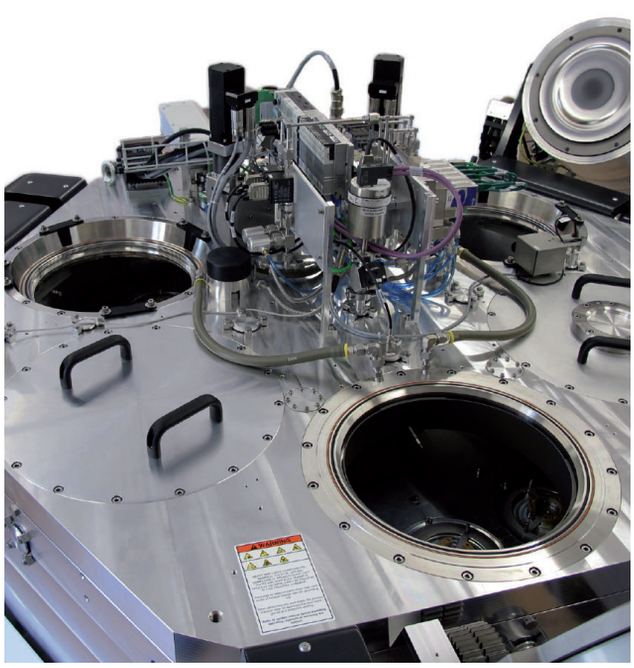




Continued growth can only be achieved through the long-term cooperation of business, science, and government

The dynamic growth of Lithuanian laser sector is evidenced by high-quality education programs, contributions of laser research community to large-scale international projects, and the products of laser companies exported to all the continents of the planet. The sales of Lithuanian laser industry have doubled in the past six years, with concomitant growth of the volume of taxes and salaries paid out. Lithuanian laser sector is essentially operating in the out-of-country market sonly, competing with the best in the field. Therefore, its development has to be viewed in the context of the global development of laser markets, where the annual growth rates between of ca. 5 and 10% were observed for the past five years, and are predicted the period of 2017-2022 by various sources. In the past twenty years, the laser sector of Lithuania has been growing significantly faster than the global market; its growth projections for 2016-2020 still exceed global trends.

The companies have performed admirably in the past five years, and secured their position in industrial laser markets. Collaboration with research institutions and between companies has remained the preferred form of interaction (as opposed to direct competition). The portfolio of products has expanded and their spectrum has diversified. The products that were novelties five years ago have been put in serial production, delivering hundreds of units per year. This required significant paradigm shift in management, when factories grew from small enterprises where all people knew each other to medium-sized companies with new people appearing on a monthly basis.



It is not all sunshine and rainbows though. There are also major challenges to be faced. The change of generations is approaching inevitably, with the numerous and talented people who started their careers in 1960s and 1970s about to retire. These are the very people who started the major laser companies and led them to the current state of the art. With this driving force subsiding, the new generations will have to shoulder the burden of pushing the limits of technology and competing globally.

The personnel situation is made worse by the demographic situation and emigration, with less students entering the universities each year in general, and physics and engineering in particular. Large number of students chose IT-related programs offering quicker and easier path to personal well-being. While laser-related master programs have been able to retain their numbers (mainly due to the strong reputation of laser industry as a solid employer), the general drop of student numbers is becoming a threat both for academic research and the industry. The point has been reached where the companies cannibalize the numbers of students at the universities, offering well-paid jobs and benefits to them even before they graduate. This means that most of the physics students work at the companies throughout their MSc studies and never even consider getting a PhD, which weakens the research institutions of the country.

Competition is also becoming more of an issue, fueled by the desire of the biggest world-class players in the laser market to keep their share of sales. The growth of Lithuanian laser industry has pushed it out of its comfortable niches and into the global waters. The products that had essentially no competition five-to-ten years ago, now have identical counterparts in the portfolios of foreign suppliers. Competing by prices is never a good idea in high-tech market; instead, the industry needs to continue innovation, which requires a special effort in companies, where most of the revenue is made by mass-production. It is too easy to get deceived by the idea that money-making activities must be prioritized, while the ‘sandbox games’ of R&D can wait, or be underfunded.

To meet these challenges, tight collaboration between the government, academia and the industry is required. The last large portion of EU structural funds must be invested wisely in the human capital, attracting the much-needed talent to physics and engineering programs, and helping the companies in their next leap of innovation. The government has to face the fact that academic personnel and graduate students need salaries at least in the same order of magnitude as the industry. Teaching of natural sciences and technological skills to the kids should be made a priority starting from the first years at school. The companies also need to realize that luring people away from the universities and institutes is only going to work so long. Mutual understanding, constant dialog and constructive collaboration between industry, academia and government is the only way forward.

Laser science and industry were active participants of the new stage of R&D development in Lithuania, defined by the governmental programs of development of integrated science, studies, and business centers (valleys), approved in November 2008. Saulėtekis (Sunrise) Valley played a special role in laser development.

Historically, almost all the laser companies in Lithuania have spinned off from two strongest scientific institutions – Vilnius University Laser Research Center, located on Saulėtekio Street, and the Institute of Physics of the Center for Physical Sciences and Technology, situated on Savanorių Avenue. Most of the companies are still located next to their parent institutions, however, some new companies are scattered around the city, with a discernible third cluster formed on the intersection of Geležinio Vilko and Mokslininkų streets.

The Laser Research Center of Vilnius University received an annex where multifunctional ultrashort pulsed laser complex Naglis is located. It functions as an integral part of the High Intensity Laser Laboratory. The research staff of the complex collaborates with research centers abroad in the development of new and promising laser and optical technologies, to be industrialized by Lithuanian laser businesses. Together with standardized component testing capabilities it makes Naglis an indispensable facility for developing highly desirable optical components able to withstand huge laser beam intensities. A startup company Lidaris, located in the same building, has commercialized several lines of research developed by Laser Research Center of Vilnius University.

On Saulėtekio Street, a new building, the National Center for Physical Sciences and Technology has opened its doors in 2016. It is a home for a number of laboratories for lasers and optics, material science and nanotechnology, semiconductors and electronics. The new clean rooms offer unprecedented possibilities for research and developing new technologies and devices. At the same time, Vilnius University Life Sciences Center has moved into their new building nearby, which opened tremendous collaboration opportunities for the physicists and life scientists which they are all keen to exploit. Further down Sauletekio Street, Sunrise Valley Science and Technology Park is located, where a number of high-tech companies have started their activities. One of them is a member of laser ecosystem, Femtika.

A little further down the road, you will find the headquarters of Light Conversion Ltd. It moved here just three years ago, in 2014. Engineers and production staff were happy to finally enjoy their newly constructed building with modern manufacturing facilities and research labs. However, the growth projections turned out to be too conservative: the building has already become too small and a new annex is being constructed.

National Center for Physical Sciences and Technology, Vilnius University Life Sciences Center and Scholarly Communication and Information Centre

National Center for Physical Sciences and Technology, home to Department of Optoelectronics (DO), Department of Molecular Compound Physics (DMCP)

Vilnius University Life Sciences Center

Vilnius University Laser Research Centre and its newly constructed annex - National and International Access Multifunctional Ultrashort Pulse Laser complex NAGLIS. Company Lidaris is located in the same building.

Sunrise Valley

Light Conversion is 4 km to the East from Laser Research Center of Vilnius University and Lidaris

Sunrise Valley Science and Technology Park hosting Femtika

The program of integrated science, studies, and business center Saulėtekis also includes Sunrise Valley Technology and Innovation Center – another location in Vilnius, originally the home of the Institute of Physics of Center for Physical Sciences and Technology (FTMC). Here, for more than 30 years, business and education work hand in hand. Several divisions of the Center for Physical Sciences and Technology are still here, along with the Science and Technology Park of Institute of Physics and laser companies Ekspla, Eksma Optics, ELAS, Optida, Optonas, Teravil. Here you will also find Science and Technology Park of the Institute of Physics carrying out their highly successful project called Laser & Engineering Technologies Cluster. The Cluster has become home to an integrated dynamic chain of researchers, suppliers, manufacturers and vendors, who joined their efforts in improving global competitiveness of laser and engineering companies, exchanging expertise and developing new high added-value products.

The center holds technological training workshops forging ties between company employees and university students and organize business-targeted PhD programs. Technological and non-technological research of laser-related products and services, manufacturing processes, and supply chains is planned.

Science and Technology Park of Institute of Physics

Department of Laser Technologies (DLT) of Center for Physical Sciences and Technology

Ekspla

ELAS

Eksma Optics

Optida

Teravil

Optonas

In the spring of 2013, several laser companies have started their activities in the third area, populated by ultramodern building of Baltic Optical Disc (BOD) Group, dedicated to the experimental production of solar cells and modules and research laboratories, and Visoriai Information Technology Park. The location is on the intersection of Geležinio Vilko and Mokslininkų streets, complementing the photonics territory started by EKSMA group on Mokslininku Street back in 1988.

Eksma

Eksma Optics

Altechna

Workshop of Photonics

Quantum Light Instruments

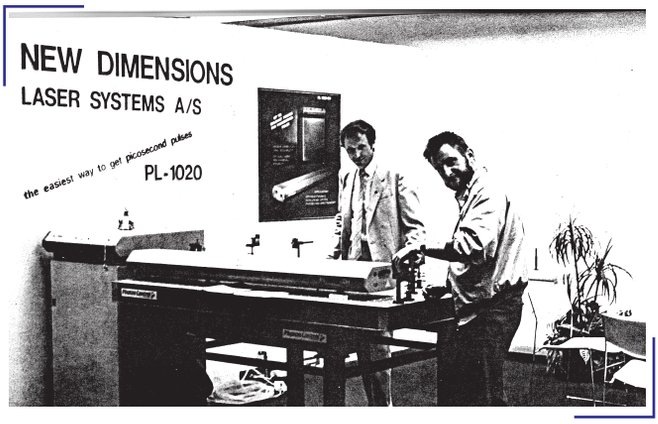
Sprana

Optogama

Direct Machining Control

Evana Technologies

Laser industry and research is one of the fields where Lithuania is visible on the global map. In 2017, we celebrated the 30th anniversary of showing Lithuanian lasers to the Western world: the largest European laser exhibition in Munich hosted a laser developed and manufactured by Eksma. Since then, three decades of continued efforts have yielded their fruits. In 2016 we celebrated the 50th anniversary of the first laser launch in Lithuania.



Munich, West Germany, Laser Fair 1987. V.Mačiulis and K.Jasiūnas are demonstrating a picosecond laser in the West for the first time.

Munich, Germany 2011.
Lithuanian pavillion in Laser World of Photonics 2011

Munich, Germany 2015.
Lithuanian pavillion in Laser World of Photonics 2015

- 1978. The first international event in the field of lasers and nonlinear optics is organized in Vilnius, the 1st Vilnius International School on Laser Applications in Atomic, Molecular, and Nuclear Physics (ISLA'78). Organizers include Vilnius University, the Lithuanian Academy of Sciences, and the Institute for Spectroscopy of the Russian Academy of Sciences, Troitsk. Presentations were delivered in the form of tutorial lectures. Due to great success of this school it later became a periodic school held in Vilnius every three years. The next five schools were held in 1981 (ISLA'81), 1984 (ISLA'84), 1987 (ISLA'87), 1990 (ISLA'90), and 1993 (ISLA'93) respectively. The number of participants varied in the range of 80–100.
- 1983. Establishment of the first laser company Eksma.
- 1984. USSR National Conference on Non-Resonant Interactions Between Optical Radiation and Matter is held in Palanga. Organizers included the Institute of Physics (Lithuanian Academy of Sciences) and Vavilov State Optical Institute (Leningrad, currently St. Petersburg).
- 1987. Vilnius hosts the 5th (UPS'87) International Symposium on Ultrafast Processes in Spectroscopy. UPS symposiums were organized under the auspices of the European and Lithuanian Physical Societies, Vilnius University and the Lithuanian Academy of Sciences. Scientists from widely varying fields in physics, chemistry, biology, and medicine got together to share their common interest in ultrafast processes taking place on picosecond and femtosecond time scale. The number of invited and contributed papers in those conferences was in the range of 100-120. The event returned to Vilnius six years later (UPS'93).
- 1987. Eksma participates in their first trade fair in the West.
- 1992. Prof. A. P. Piskarskas is awarded Alexander von Humboldt Research prize, followed by the European Physics Society prize in quantum electronics and optics in 2001.
- 2002. Vilnius hosts the International Conference on Laser Applications in Life Sciences (LALS-2002) covering the fields of Biomedical Imaging, Laser spectroscopy, Laser-Tissue Interactions, Light Microscopy, organized by Vilnius University and Moscow Lomonosov University. The number of participants was about 100.
- 2007. Two companies, Light Conversion and EKSPLA, together with the head of Quantum Electronics Department and Laser Research Center of Vilnius University Prof. A. P. Piskarskas,

Light Conversion Science Director Dr. R. Danielius, Eksma executive R. Kraujalis and Ekspla executive K. Jasiunas, were awarded the National Progress Prize for the consolidation of Lithuanian laser science and industry for the breakthrough to the global markets.

- 2009. Vilnius hosts the International Conference Northern Optics 2009 (NO 2009), the 4th conference in the Northern Optics series. The aim of the meeting was to bring together optical scientists and people from the optics industry and optics companies in the Nordic and Baltic countries. The conference was organized by the Lithuanian Physical Society including Vilnius University and the Institute of Physics (Vilnius). The number of participants was 120.
- Laser, optics and photonics scientists receive Lithuanian Science Awards (started in 1993) every second or third year.
- The sales volume of laser companies has been consistently growing 15-20 % per year in the past decade. From EUR 12 million in 2003, they have reached more than EUR 60 million in 2013, which is more than five-fold.
- 2011. Ekspla receives the Prism Award for Photonics Innovation, the so-called laser Oscar.

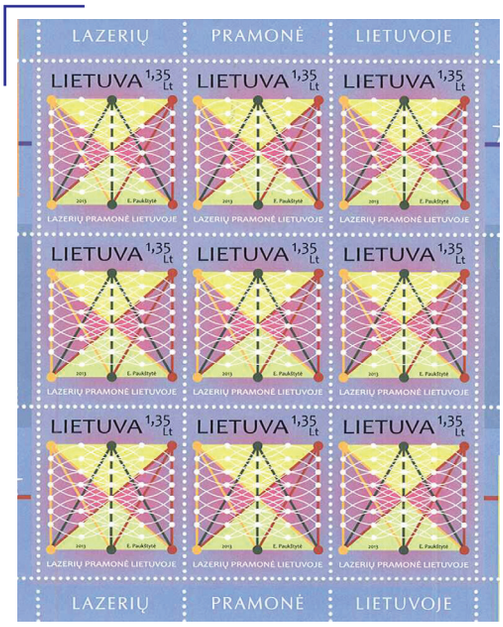
- 2011. EU Commissioner for research, Máire Geoghegan-Quinn, visits Light Conversion.

- 2011. Optolita becomes a certified supplier for the European Space Agency.
- 2011. The Lithuanian Center for Physical Science and Technology signs a long-term collaboration agreement with the largest Japanese research institute RIKEN.
- 2011. Altechna is awarded the German Business Award, Responsibility for the Future.

- 2011. Altechna receives the Swedish Business Award for the most sustainable growth.
- 2012. Ekspla receives the Swedish Business Award for the best introduction of Lithuanian products in foreign markets, for promotion of Lithuania's name in the world.

- 2012. Prof. A. P. Piskarskas is awarded the Baltic Assembly Prize for his pioneering research in the field of laser physics and nonlinear optics, for the development of innovative laser instruments and fruitful international collaboration in the European area and world-wide.
- 2012. The President of the Republic of Lithuania Dalia Grybauskaitė visits Ekspla.

- 2012. The Congress Life Sciences Baltics names the company Integrated Optics one of the most promising start-ups.
- 23 February 2013.The Lithuanian Post issues a new postage stamp called Laser Industry in Lithuania from the series Science Breakthroughs.



- 2013. Light Conversion receives the Lithuanian Business Leaders' Award as the most efficient company.
- 2014. The new building of Light Conversion is opened by the President of the Republic of Lithuania Dalia Grybauskaitė.

- 2014. Vilnius hosts the 15th International Symposium on Laser Precision Microfabrication (LPM 2014). The number of participants was about 230, making it the largest laser-related conference ever held in Lithuania. LPM is the world's number one meeting of the laser user community where the most advanced developments and recent trends in laser application for fine and precise fabrication of diverse materials are discussed among industry, research and academia representatives. The symposium provided a floor for researchers, end users of lasers and laser manufacturers to discuss the fundamental aspects of laser-matter interaction, the state-of-the-art of laser material processing, and topics for the next generation. It was organized by the Center for Physical Sciences and Technology (FTMC), Lithuania and Japan Laser Processing Society (JLPS), Japan.
- 2014. Light Conversion received the Swedish Business Award for the sustainable growth.
- 2015. Sunrise Valley of Technology and Innovation is opened by the President of Lithuania, Dalia Grybauskaitė. 'Our scientists have much to offer to the world in the field of high technologies. Investments in high-tech not only result in developing of progress but also create new jobs and attract foreign investment to Lithuania' the President said.

- 2015 Sunrise Valley Technology and Innovation Centre is visited by the experts from the Organisation for Economic Co-operation and Development (OECD).
- 8 October, 2015. The Swedish royal couple - King Carl XVI Gustaf and Queen Silvia accompanied by the Prime Minister Mr. Algirdas Butkevičius and his wife Jolanta Butkevičienė visit Sunrise Valley Technology and Innovation Center.

- 2016. Corning Incorporated (NYSE: GLW) and Workshop of Photonics on February 4, have entered a Joint Development Agreement to work together on the development of new laser glass processing technologies. Michael Müller, Managing Director of Corning Laser Technologies, one of the world's leading innovators in materials science, said: "We believe this strategic relationship with Workshop of Photonics will enhance our ability to deliver innovative laser processing solutions for glass".
- 2016. A golden €5 coin dedicated to Physics was issued by the Bank of Lithuania. The obverse of the coin features, a stylised Vytis in the centre, depicted against a background of interfering coherent light waves, surrounded by the inscription LIETUVA (Lithuania), year of issue (2016), denomination (€5), and the mintmark of the Lithuanian Mint. The reverse shows a laser beam, symbolizing laser physics.

- 2016. The National Centre for Physical Sciences and Technology was opened. The National Centre of Physical and Technological Sciences now headquartered in a four-storey building of 27 thousand square meters in the Sunrise (Saulėtekio) Valley is the largest and most advanced base for physical, chemical sciences and technology in Lithuania and the Baltic states.
- Thanks to the MatchBox2 Series of lasers Integrated Optics was named one of the top 3 finalists in the category of scientific lasers for the Prism Awards for Photonics Innovation.
- 2016 The review of customer bases of Lithuanian laser companies revealed that 90 out of top 100 universities in the word use Lithuanian laser products.
- 2016 EPIC organized in Lithuania an executive-level meeting on laser material processing. There were 65 people from 20 countries, there were a lot of presentations, company visits, networking dinners and receptions.
- 2017. Main prize in the Vilnius Invent contest was awarded to researchers of FTMC Karolis Ratautas and Mindaugas Gedvilas for their patented laser technologies.
- In the past three years, six new laser companies have been founded, including Ato ID, Direct Machining Control, Holtida, Integrated Fiber Optics, Optogama and Oriental Technology Solutions. Currently, the total number of companies is 30. It is also worth stressing that all the companies in the community, starting from the first one (founded in 1983), and ending with the novices (established in 2017) continue their operation successfully to this day – none have closed down.

EPIC 2016 meeting participants assembled in the Cathedral Square in Vilnius for an early morning jogging. The mayor of Vilnius Mr. Remigijus Šimašius (the tallest person standing in middle left) has joined the event despite the early hour – a welcome display of respect to the laser community.

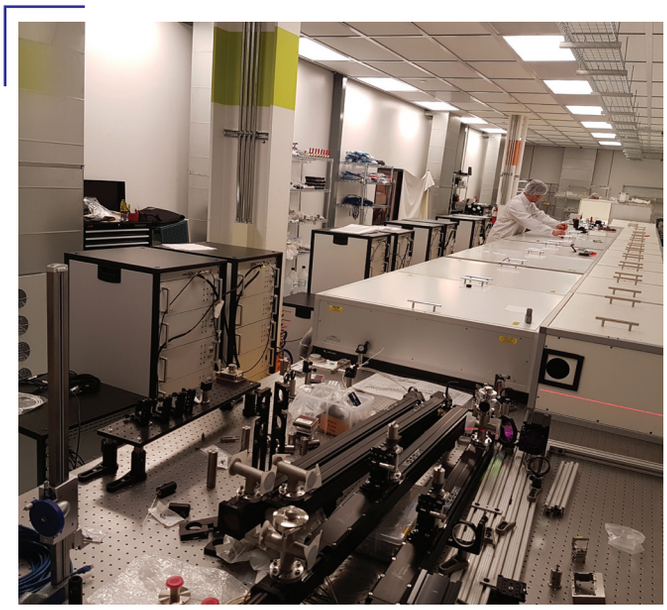
Laser technologies developed in Lithuania enter space exploration programs

- Lithuanian company Optolita, part of Eksma Group, is a manufacturer of ultraprecise optical components for the satellite developed by the European Space Agency. The satellite Aeolus dedicated to the laser-based exploration of Earth atmosphere will use optical converters manufactured from non-linear crystals and coated in Lithuania.
- The precision mechanical components developed and manufactured by Standa, another Lithuanian company, are already in use in satellites. Many innovative solutions were required to enable their operation in nearly absolute vacuum and temperatures approaching absolute zero.
- In 2016 Lithuanian company Lidaris, which provides professional laser damage testing services, and European Space Agency (ESA) started a two-year collaboration project ESPRESSO. The overall aim of the project is to carry out research and development work necessary to predict optic's longevity required by space programs.

Lithuanian lasers for research at highest intensities and shortest time scales

- 2013. TW-class laser system based on OPCPA technique 10 Hz operating at repetition rate was demonstrated at the Laser Research Center of Vilnius University in A more advanced version of this system generating ⍰ 1 TW peak power sub-10 fs pulses at 200-1000 Hz repetition rate and providing possibilities for cutting-edge research on laser-matter interaction at extreme light intensities is scheduled to come online at Vilnius University laser facility NAGLIS by the end of 2017.

- 2014. A consortium led by National Energetics, Inc. in partnership with Ekspla was awarded a contract to develop and install an ultra-intense laser system producing 150 fs pulses with power in excess of 10 PW for the European Union's Extreme Light Infrastructure Beamlines (ELI-Beamlines) facility in the Czech Republic. In 2017, Ekspla's part was completed and shipped to the USA for further integration. The entire system is expected to be shipped to Prague by the end of 2017, where the installation should be over before the end of 2018.
- In 2014 the consortium made of Ekspla and Light Conversion was awarded a European contract for designing and building the laser system for ELI-ALPS facility in Hungary.
- 2017. OPCPA-based laser system that will be the core component of a unique Attosecond Light Pulse Surce at Extreme Light Infrastructure ELI-ALPS Laser Research center in Szeged, Hungary was finished and demonstrated to the customer on the manufacturer's facilities. The OPCPA system provides CEP stable sub-10 fs pulses with power of 4.5 TW at repetition rate of 1 kHz.



Laser front end in the facility of National Energetics Inc.

Vilnius University
Faculty of Physics
Laser Research Center

Head: Prof. Dr. Valdas Sirutkaitis
Professors: 10
Researchers with PhD degrees: 20
PhD students: 21

Laser research was started at Vilnius University in 1969 by several young researchers who did their graduate research at Lomonosov Moscow State University. In 1974, the Department of Astronomy and Quantum Electronics (QED) was founded at the Faculty of Physics; Laser Research Center (LRC) established in 1983 has significantly expanded the experimental infrastructure available for research. Since its foundation, the department has graduated more than 600 students in laser physics, and more than 50 young researchers have completed their PhD research. Currently, the LRC employs around 40 permanent staff, among which 10 doctors with habilitation qualification and 20 PhDs. Each year, the department hosts around 20 graduate students and more than 40 students follow MSc programs. At modern labs, covering more than 2 000 square meters, research groups are investigating the phenomena of ultrashort pulse optics, biophotonics, laser nanophotonics, laser-induced breakdown and optics testing, parametric light phenomena, ultrafast spectroscopy and femtosecond technology.
LRC has been a member of the European Integrated Laser Infrastructure LaserLab since its inception in 2004, providing transnational access for the researchers from all around the EU. The scientists are involved in joint research activities with the colleagues from the best European scientific centers. The infrastructure for science and studies was further expanded using the funds provided by several recent European Structural Fund projects.
VU LRC maintains close collaboration with laser industry, not only in training the students for laser related jobs, but also performing the research projects to test the ideas for future products and developments.

Address: Saulėtekio Ave. 10, LT-10223 Vilnius, Lithuania
Website: http://www.lasercenter.vu.lt/

Vilnius University
Semiconductor Physics Department and
Institute of Applied Research

Department head: Prof. Dr. Gintautas Tamulaitis

Director of the institute: Prof. Dr. Saulius Juršėnas
Professors: 12
Researchers with PhD: 32
PhD students: 17

The study of optical properties of semiconductors by using lasers was started at the Semiconductor Physics Department back in the late 1960s and has now evolved into extended investigation of semiconductors and semiconductor heterostructures for electronic and optoelectronic applications. Temporally and spatially resolved luminescence spectroscopy and nonlinear optical techniques are employed as tools to study the interaction between light and semiconductor materials. Research results enable the development of novel solid-state light sources – light-emitting diodes and laser diodes emitting in a wide spectral range, currently expanding into UV region. Research is also focused on the application of solid-state light sources for the detection of hazardous agents, in medicine and transport, disinfection, plant cultivation, customized lighting solutions. Most of the major projects currently being implemented in the total amount of over EUR 1 million per year involve laser light sources as tools to study or fabricate semiconductor devices or materials. Annually, three to four PhD theses are completed.

Address: Saulėtekio Ave. 9, Bldg. III, Vilnius
Website: http://www.ff.vu.lt/lt/

Vilnius University Laser Research Center Facility “Naglis”

Head of the open access center: Dr. Arūnas Varanavičius

We are the laser center of excellence with the longest history in Lithuania. Laser Research Center (LRC) established in 1983 on the basis of Department of Quantum Electronics of Vilnius University, where laser science has been developing since 1969. Later, in 2013, LRC started to provide access to their R&D resources at the open access center *Laser Research Center Facility “Naglis” of Vilnius University.*

Core research and services:
- Optics characterization and laser damage testing
- Nonlinear optics
- Laser 3D micro/nanostructuring
- Femtosecond laser fabrication
- Ultrafast spectroscopy

State-of-the-art laboratories with the wide range of ns and fs laser systems open to business and researches:
- *R&D technology development services.* We pay great attention to development of technologies and new laser sources in cooperation with companies from the laser technology sector,
- *Joint business and science projects,*
- *Laboratory facilities for hire.* We provide access to unique laser systems and measurement devices for qualified employees of business companies.

Address: Saulėtekio Ave. 10, LT-10223 Vilnius, Lithuania
E-mail: laser.apc@ff.vu.lt
Website: http://www.lasercenter.vu.lt/

Center for Physical Sciences and Technology (FTMC)

Department of Laser Technology (FTMC)
Head: Dr. Gediminas Račiukaitis

Researchers with PhD degrees: 22
Graduate students: 16

DLT consists of six laboratories: Laser Microfabrication Technologies, Fiber Lasers, Solid-State Lasers, Optical Coatings, Nanophotonics and 3D Technologies and Robotics.
The main topics of research include the development of optical components, fiber and solid-state lasers and their applications in material processing. The research results are used in the production of sophisticated dielectric optical coatings, high pulse energy fiber lasers, and high power pulsed solid-state lasers for custom applications. The interactions between laser radiation and materials are investigated with focus on novel laser micromachining methods. Part of the research is also directed at the modeling, creation, and characterization of nanophotonic structures, waveguides and metamaterials for light control.
FTMC DLT offers its services for development and implementation of customized laser-based micromachining technologies, specialized solid-state and fiber lasers. It also provides design services, and small-scale production of dielectric optical coatings; in addition, it performs the modeling of light propagation in waveguides and photonic crystal structures.

Address: Savanoriu Ave. 231, Vilnius, Lithuania
Website: http://ftmc.lt

Department of Molecular Compound Physics (DMCP)
Head: Prof. Dr. Leonas Valkūnas

Professors: 2
Researchers with PhD degrees: 14
PhD students: 2

DMCP is comprised of the laboratories of Ultrafast Spectroscopy and Biophysical Research. Research at DMCP is focused on better understanding of photo-induced electronic phenomena in various organic and hybrid systems designed for applications in organic optoelectronics.
Ultrafast spectroscopic methods are widely applied in the investigations of excitation dynamics in molecular compounds, determining optical and electric properties of molecular materials. For better understanding of photoelectric properties of molecular devices, optical techniques are combined with electrical methods. Ultrafast spectroscopic techniques are applied in the research of primary events in photosynthesis, which are modeled using high-level theory; excitation dynamics and charge separation models are developed. CARS and multi-photon fluorescence microscopies are developed in the department in order to visualize details of biological and other molecular objects with sub-micron resolution.

Address: Saulėtekio Ave. 3, Vilnius, Lithuania
Website: http://ftmc.lt

Department of Optoelectronics (DO)
Head: Prof. Habil. Dr. Arūnas Krotkus

Professors: 1
Researchers with PhD degrees: 14

The Department of Optoelectronics includes the laboratories of Ultrafast Optoelectronics, Optoelectronic Technologies, Terahertz Photonics, Optoelectronic Systems, and Semiconductor Optics.
The main goal of the DO is the creation of scientific and technological infrastructure for business and society that will allow to develop novel optoelectronic devices and optoelectronic systems, and to maintain the competence required for employing these technologies.
The focus of the Optoelectronic technology lab is centred on the growth of dilute bismide layers and structures for terahertz and mid-infrared detectors and emitters. The structures are grown using molecular beam epitaxy. The laboratory was first to fabricate bismide-based THz components and IR laser diodes.
THz Photonics lab has developed the first compact THz imaging arrays operating at room temperature that are suitable for security and diagnostic systems. As a consequence, terahertz spectroscopy of carbon nanostructures and their composites has emerged.
Ultrafast Optoelectronics lab is developing efficient THz emitters activated by femtosecond laser pulses and performing research on carrier dynamics in novel semiconductor materials whereas laboratory of Semiconductor Optics is employing spectral ellipsometry and various modulation spectroscopies for the study of hybrid synthetic photonic opals, quasicrystals and quantum semiconductor structures.

Address: Saulėtekio Ave. 3, Vilnius, Lithuania
Website: www.ftmc.lt

BALTFAB

Manager Dr. Romualdas Trusovas

BALTFAB is an open access facility within FTMC with tools and expertise in emerging micro/nanofabrication techniques. Our key feature is multidisciplinary research and competences from photonics and light manipulation to biomaterials and nanobiotechnology. Laser physicists with theoreticians, cell biologists, experts in electro- and organic chemistry and biophysicists are gathered under one roof from the Departments of Laser Technologies and Nanoengineering.

Keywords

- Biocompatible surfaces and biochips
- Electrochemical and plasmonic sensor development
- Laser equipment development: e.g. fiber laser system with control software
- Laser micromachining and lithography
- Soft and scanning probe nanolithography
- Optical coatings, waveguides and photonic-crystals
- Ellipsometric SPR simulations and measurements of self-assembling
- Synthesis of custom organic materials

Our multidisciplinary team is ready to investigate the synergies between unconventional fabrication methods and explore the possible combinations. BALTFAB is open for technology consultation, training and education.

Address: Savanoriu Ave. 231, Vilnius, LT-02300, Lithuania
Website: www.baltfab.lt

Science and Technology Park of Institute of Physics

Founded: **1994**
Director: Julius Paužolis

Science and Technology Park of Institute of Physics (STP) is a non-profit organization active in the fields of optoelectronics and precise engineering, innovations, knowledge society and scientific research. Implementation of research results and promotion of cooperation between science and industry are main activities of STP. The objective of the park is to provide assistance for companies, working in the fields of applied research and experimental development. STP helps in commercializing the results of scientific research carried out by research institutes and universities, and stimulates the integration of business, science and studies in the fields of physical and technological sciences, thus promoting export, contributing to the competitiveness of the country and assisting the growth of knowledge-based economy. STP performs the functions of technological business incubation, hosting the companies under favorable conditions and providing the services of business management, information, consulting, qualification training, accounting, etc.

Address: Savanorių Ave. 235, Vilnius, Lithuania
Website: www.fimtp.lt

Laser & Engineering Technologies Cluster

Founded: **2011**
Coordinator: Science and Technology Park of Institute of Physics

Laser & Engineering Technologies Cluster LITEK brings together companies and organizations operating in the sectors of lasers and associated technologies. Among the members of LITEK we can find the biggest research institute of Lithuania with a strong background in laser technologies, also science and technology park, that coordinates cluster, various SMEs for optical and optomechanical component production, optical coatings, metal processing, 3D printing, prototyping, laser systems developing, installation of machining systems and etc. LITEK cluster has strong connections with more than 50 companies and 10 research and technology organizations working in fields of optoelectronics, optical materials and lasers. The overall goal of the cluster is to create a dynamic center that would have a fully integrated chain of researchers, suppliers, manufacturers and retailers. Such integration would promote the international competitiveness of laser and laser-related engineering technologies and contribute to the dissemination of the knowledge and well-being of the individual members of the cluster. LITEK is always looking for new ways to support the development of new cross-sectoral industrial value chains across the EU.

Address: Savanorių Ave. 235, Vilnius, Lithuania
Website: www.litek.lt

National Cancer Institute Laboratory of Biomedical Physics

Head: Prof. Dr. Ričardas Rotomskis

Professors: 1
Researchers with PhD degrees: 3
PhD students: 4

Research of interactions between laser radiation and biological objects began at Vilnius University Laser Research Centre in the 1970s. In 1989, the Lithuanian Oncology Center has started applying photodynamic cancer therapy employing lasers. More than 700 patients received treatment. The Biomedical Physics Laboratory was founded in 2004. It continues research of interactions between laser radiation and biological objects, including techniques and methods of optical biopsy, photosensitized cancer therapy, biomedical imaging, nanobiophotonics and nanomedicine. Temporally and spatially resolved luminescence spectroscopy and nonlinear optical techniques are employed as tools to study the interaction between light and different types of nanoparticles (semiconductor, gold, magnetic, fluorescent, up-converting etc.) in aqueous solutions and bio-models. Fluorescence lifetime imaging, confocal microscopy of biologicaly active molecules and nanoparticles are performed in cells cultures and experimental animals. The laboratory maintains close collaboration with the University of Oslo and the Norwegian Radium Hospital in Norway, Leibniz-Institute of Photonic Technology (Jena) in Germany.

Address: Baublio St. 3B, Vilnius, Lithuania
Website: www.nvi.lt

The General Jonas Žemaitis Military Academy of Lithuania Department of Engineering Management

Head: Prof. Dr. Aušrius Juozapavičius

Professors: 2
Researchers with PhD degrees: 6

The department was founded in 1994. One of the directions of research pursued was the detection of explosives and pollutants using laser-based methods. The scientists of the department had developed selective methods and sensitive equipment for detecting pollutants on army training grounds and the environs, using modern laser techniques. Currently, the department is involved in a research of detection of THz radiation from quantum cascade lasers using silicon CMOS detectors in close collaboration with the Noise and THz Labs of Vilnius University.

Address: Šilo St. 5A, Vilnius, Lithuania
Website: www.lka.lt

Kaunas University of Technology
Institute of Materials Science
Department of Surface and Thin Film
Research Laboratory of Optical Technologies

Head: Dr. Mindaugas Andrulevičius

Professors: 1
Researchers with PhD degrees: 4
PhD students: 2

The laboratory is involved in the applications of laser technologies and optical spectroscopy methods. Ultra-fast Yb:KGW laser system is employed for precise multiple wavelength micro/nano fabrication of broad range of materials as well as for the transient absorption spectroscopy measurements. Techniques based on continuous wave and pulsed laser interference as well as focused laser beam exposure are used for the formation and analysis of periodic microstructures for development on novel optical security features of documents. Optical sensors for real-time monitoring of refractive index in liquids are developed and applied in the analysis of biological processes. Soft lithography replication techniques together with capillary assisted particle deposition methods are employed for plasmonic nanoparticle and fluorescent microparticle deposition in regular arrays for photonic applications. Plasmonic properties of nanocomposites are studied by the spectroscopic ellipsometry. The laboratory collaborates with the University of Southern Denmark, National Institute of Materials Science (Japan) and other scientific centers abroad.

Address: K. Baršausko St. 59, Kaunas, Lithuania
Website: materials.ktu.edu

Kaunas University of Technology
Faculty of Mechanical Engineering and Design
Department of Production Engineering

Head: Dr. Kazimieras Juzėnas

Professors: 4
Researchers with PhD degrees: 41
PhD students: 5

The department pursues research activities related with the applications of lasers in production processes. Directions of research include the effects of laser irradiation in the thermal processing and microstructuring of engineering materials, laser welding and cladding, laser applications in rapid production systems, and integration of laser technologies in production systems. Research activities are also related with optical measurements and characterization of materials and structures. The department collaborates with Lappeenranta University of Technology in Finland, Ilmenau University of Technology in Germany, Tallinn University of Technology in Estonia and other universities and research centers.

Address: Studentų St. 56, LT–51424, Kaunas, Lithuania
Website: www.ktu.edu

Vilnius Gediminas Technical University
Faculty of Mechanics
Department of Mechanical Science
Research Laboratory of Vibroacoustics and Diagnostics

Professors: 6
Researchers with PhD degrees: 4
PhD students: 6

Research Laboratory of Vibroacoustics and Diagnostics
Head of laboratory: Prof. Dr. Artūras Kilikevičius

The Vibroacoustic Reseach and Diagnostics Science Laboratory (VRDSL) was established at Vilnius Gediminas Technical University, Faculty of Mechanics, Department of Machine Engineering in 1993. VRDSL performs vibrodiagnostics and monitoring of different mechanical systems: compressor stations, gas pumping stations, pump-houses, air blowers, electric motors, internal combustion motors, turbines, turbo motors, turbo generators, technological equipment (machine tools etc.), carloads, locomotives, mechanical devices, printing machines, automobiles and their components. The electro-acoustic research is directed to find solutions to commonly arising problems of detection, analysis and damping of acoustic noise and vibration. In addition, the laboratory performs research on friction losses in the sector of energy transformation, transport, and general machine production, defines wear reasons, recommends the solution for durability increase and necessary lubricant additives, and other energy saving methods; measures light levels and selects location of luminaires in work places, performs the balancing of revolving parts in workplaces. Vibrations and errors of precision linear and angular comparators are analyzed using laser-based methods.
The laboratory also investigates noise and oscillations and the methods allowing to reduce them; performs vibroacoustic assessment and diagnostics of industrial objects and mechatronic systems; testing of vibration stations; balancing of rotors; tribologic investigations (i.e. materials of lubrication, friction, wear, friction pairs); jobs of design and manufacturing of machines and equipment, scientific expertise's, researches of machine functioning quality.

Address: Basanavičiaus St. 28, Vilnius, Lithuania
Website: www.mgk.me.vgtu.lt

Vytautas Magnus University
Department of Physics
Group of Modeling of Nonlinear Optical Phenomena

Head: Ass. Prof. Dr. Valdas Girdauskas
Researchers with PhD degrees: 2

The group works on the theoretical modeling of the propagation of short laser pulses in the media with quadratic and cubic nonlinearity and thermal effects in laser active media. Numerical modeling methods for these phenomena are developed and applied in solving research problems. Other research intersts of the group is the laser-induced breakdown spectroscopy. The group collaborates with Ekspla and the laboratory of Solid State Lasers of the Institute of Physics.

Address: Vileikos St. 8, Kaunas, Lithuania
Website: www.fizika.vdu.lt

Altechna
Established: 1996
Director: Per Moller
Employees: 135

Altechna Group focuses on custom laser optics and complex solutions for laser applications per individual needs and requirements of our customers. The company provides solutions based on added value for the customer from different industries, starting with laser manufacturers and laser system integrators to R&D institutions.

Focus on customer needs:

- Custom laser optics
- Complex R&D solutions in laser optics: optical systems, laser accessories and laser optics
- Manufacturing of laser-related components: optical coatings, laser-related devices and optical systems
- Quality assurance and measurements to guarantee the highest quality

Continuous technological improvements, investments in R&D activities, complex technological solutions and professional staff with years of experience are the key factors that determine the best results of our company.

Address: Mokslininkų St. 6A, LT-08412 Vilnius, Lithuania
Website: www.altechna.com

Aštuonetas
Founded: 1994
Director: Artūras Greičius
Employees: 7

Aštuonetas offers the services of laser marking, microwelding and cutting. The company develops in-house laser marking software and equipment. The customers of the company include advertisement producers, manufacturers of optomechanical and electronic equipment, printers, jewelry producers, organizers of events and shows etc.

Address: A. Goštauto St. 12, LT-01108, Vilnius, Lithuania
Website: www.astuonetas.lt

Ato ID
Founded: 2014
Director: Evaldas Pabrėža
Employees: 2

Ato ID manufactures SERS (Surface Enhanced Raman Scattering) substrates (chips) for many applications ranging from environmental and food security to detection of explosives, drugs, narcotics or identifiction of infectious diseases of an early-stage.
The company brings in the next generation disposable sensors to material analysis in life sciences. The proprietary technology provides rapid label-free identification for various target molecules which are important for many applications ranging from biomarker detection in diagnostics to environmental and food security. Being eight times more sensitive than the current gold standard on the market, patented sensors feature low cost, uncomplicated production and good repeatability. The biggest advantages lay in single and simultaneous analysis for multiple targets and elimination of expensive reactants or time-consuming sample preparation steps associated with other techniques.
Raman spectroscopy is one of the most flexible and accurate technologies for molecular diagnostics. The only drawback - usually low intensity of Raman scattering signal - is eliminated by using a plasmonic SERS substrate, sputter-coated with silver (or gold), significantly enhancing the Raman signals. Silver coted SERS substrates “Randa” and “RandaS” work with wide range of excitation wavelengths – from blue to infrared – and are low cost for routine diagnostics. Gold SERS substrate “Mato” and “MatoS” are ideally suited for applications in the red and NIR excitation wavelength range.

Address: Kalvarijų St. 125B, LT-08221, Vilnius, Lithuania
Website: www.atoid.com

Brolis Semiconductors
Founded: 2011
Director: Dominykas Vizbaras
Employees: 15

Brolis Semiconductors is a vertically integrated semiconductor high-tech company developing infrared laser diodes and light emitters and electro-optic systems for research, defense and medical applications.
Company runs a state-of-the-art 210 m2 class ISO 6 cleanroom facility dedicated for III-V molecular beam epitaxy, laser diode packaging, micro-optics assembly and electro-optic system assembly and testing. Brolis is ISO 9001:2015 certified.
Products include: laser diodes and broadband gain-chips in 800 nm – 3000 nm spectral range, external cavity tunable lasers, laser diode modules for DIRCM, thermal, SWIR and NIR sights, military lasers and laser systems.

Address: Molėtų Rd. 73, LT-14259, Vilnius, Lithuania
Website: www.brolis-semicon.com

Direct Machining Control
Founded: 2015
Director: Tadas Kildušis
Employees: 1

Direct Machining Control creates software "DMC" that controls laser machines. Applications range from laser micromachining like laser etching, drilling, engraving to laser additive manufacturing (SLS, SLM, SLA, 2PP).
DMC is a fusion between CAD/CAM and machine control software focused specifically on laser applications. It combines motion trajectory generation based on 2D or 3D CAD models and controlling a wide range of hardware (positioning stages, galvo scanners, lasers, cameras, and various sensors) to perform laser machining with user defined parameters. This allows saving a lot of time for process preparation and development.
Direct Machining Control works together with variety of motion control companies, laser micromachining R&D centers and system integrators to provide laser system users a user intuitive and efficient way to control their laser machines.

Address: Mokslininkų St. 2A, LT-08412, Vilnius, Lithuania
Website: www.directmachining.com

Eksma
Founded: 1983
Director: Dr. Petras Balkevičius
Employees: 12

Eksma is an umbrella company of a group that has been working in high technologies for over 30 years. *Eksma Group* includes three companies involved in laser technologies, *Ekspla*, *Eksma Optics* and *Shanghai Eksma Laser Technologies Co., Ltd.* The start of *Eksma Group* was in 1983, when the Experimental Plant of Laser and Electronic Equipment was established at the Institute of Physics of the Academy of Sciences. In 1988, *Eksma* was the first company in Lithuania, rented out by the state to its employees. Eksma is a shareholder of the joint Lithuanian-Russian company *Sibirskij Monokristall-Eksma* specializing in the growth of nonlinear and laser crystals. In addition to laser business, the company is involved in the sales, installation and support of medical and laboratory equipment (*Eksma* is one of the large shareholders of *JSC Bioeksma*).

Address: Mokslininkų St. 11, LT-08412, Vilnius, Lithuania
Website: www.eksma.lt

EKSMA Optics
Founded: 2006
Director: Dainius Tumosa
Employees: 47

EKSMA Optics is a manufacturer and supplier of precision laser components used in high power lasers, laser systems and in other photonic instruments.
Utilizing more than 30 years of expertise in the laser and optics fields the company has proven experience providing custom solutions for scientific community and OEMs and also offering a wide range of catalogue products for the fast off-the-shelf delivery.
Product range includes:

- Laser optics
- Precision grade spherical, aspherical and axicon lenses
- Pockels cells with DKDP, BBO and KTP crystals
- Ultrafast pulse picking systems
- Laser media & nonlinear crystals for UV, VIS, IR and THz ranges.
- Opto-mechanical mounts, motorized stages and tables

EKSMA Optics polishing facility specializes in the processing and final polishing of flat optics made of BK7, UVFS, Infrasil, Suprasil, CaF2 and also DKDP, KDP, LBO, BBO, ZnGeP2 crystals whereas high quality precision polished faces are required for high power laser applications. The Company also owns advanced IBS coatings facility, CNC manufacturing facility for spherical, axicons and aspherical lenses, clean room facilities for BBO, DKDP and KTP Pockels cells assembling, technical division for manufacturing of ultrafast electro-optical pulse picking systems and quality control laboratories.
EKSMA Optics is an ISO 9001:2008 certified company.

Address: Mokslininkų St. 11, LT-08412, Vilnius, Lithuania
Website: www.eksmaoptics.com

Ekspla
Founded: 1992
Director: Kęstutis Jasiūnas
Employees: 126

Ekspla is a manufacturer focusing on high-performance advanced solutions. Drawing on 30 years of experience and close partnership with the scientific community, it designs, develops and manufactures solid-state lasers, laser systems and accessories for R&D and industrial applications; complete spectroscopy systems; ultrafast fiber lasers; high energy laser systems; and laser optoelectronics.
Strong R&D team enables customizing and supplying products from single unit to OEM series. In-house design and manufacturing ensures operative development and manufacturing of new products. Products are available from several standard units for R&D applications to series customized solutions for OEM (Original Equipment Manufacturers).
The in-house design and manufacturing ensures effective development and launch of new products. High peak power laser systems, short pulse generation and amplification, tuneable nonlinear OPO/OPG/OPA and nonlinear spectroscopy are among *Ekspla* core competencies. The company is one of the few in the world that make SFG spectrometers for material surfaces investigation.
Ekspla exports 90 % of its production to more than 60 countries worldwide. Customers include the most famous universities across Europe, the USA and Australia, CERN, Cambridge University, Lawrence Livermore National Laboratory, NASA, RIKEN Nishina Center in Japan and the Chinese Academy of Sciences.
EKSPLA has become proficient in carrying out EU projects, both international (FP7, EuroStars, Eureka) and national (in the framework of structural funds). The cooperation involving numerous partners taught new knowledge and skills, and widened EKSPLA's scope.
In 2011, EKSPLA became the first company from Central and Eastern Europe to win the *Prism Award for Photonics Innovation* (known as the Oscar of the photonics industry). In 2012, *Ekspla* was named the Business IQ of the Year at the Swedish Business Awards ceremony. Every two years the national *Innovations Prize* is received either for some exceptional new product or awarded to the entire company.

Address: Savanorių Av. 237, LT-02300 Vilnius, Lithuania
Website: www.ekspla.com

ELAS Ltd.
Established: 2010
Director: Saulius Mikalauskas
Employees: 11

ELAS Ltd. is Lithuanian designer and manufacturer of laser micromachining systems for industrial and scientific applications. Highly customized micromachining workstations incorporate nanosecond, picosecond and femtosecond laser sources in combination with advanced beam steering in order to achieve micrometer scale machining precision and repeatability.
In-depth knowledge of micromachining processes constantly created in two associated application labs is the major strength of Elas' engineers. Processes are tested for feasibility, tuned for performance and skillfully implemented into reliable and efficient workstations.
Know-how is accumulated mainly for ablation, drilling, scribing and intro-volume marking processes, whilst the ever growing range of materials, already includes silicon, SIC, sapphire, diamond, tungsten carbide, biological materials, biodegradable polymers, glasses, majority of metals, ferroelectric ceramics, etc.
Special attention is always paid to ergonomics and safety of the systems. Company's advantage is the ability to meet sophisticated functionality requirements. ELAS' customers vary from world-famous universities, research centers to industrial companies.
APPLICATIONS:

- Cold micro-marking of metals
- Processing of thin film solar cells
- Flexible manufacturing and selective polymer ablation for electronics
- Silicon, glass and sapphire wafer cutting and scribing
- Treatment of mechanical tools made of metal, synthetic diamond or ceramics
- Medical device manufacturing
- Patterning of optical and metal coatings
- Driiling of fuel injector nozzles and mechanical filters

Address: Savanoriu Ave. 235, LT-02300, Vilnius, Lithuania
Website: www.e-lasers.com

FEMTIKA
Founded: 2013
Director: Vidmantas Šakalys
Employees: 12

Femtika is a fast growing spinoff company of Vilnius University Laser Research Centre. The company has deep working knowledge in the area of laser based precision 3D microfabrication technologies.
Highly skilled personnel of Femtika employ cutting-edge laser equipment in the following two directions:

1) research services for scientific institutions and industry in microfabrication of different products in milli-, micro- and nanoscale;
2) development of automated microfabrication equipment driven by high-average power femtosecond lasers.

Femtika has a wide expertise and know how in several microfabrication processes, namely hybrid microfabrication technologies that allow combining different fabrication regimes and methods using a single femtosecond laser source. This not only enables the precise fabrication of complex components or structures required by the customers, but also allows expanding the range of materials used for fabrication.
Today *Femtika* has mastered and the following microfabrication technologies:

- Three-dimensional polymer micro and nanofabrication technology based on ultrafast laser initiated polymerization reaction;
- Direct laser witting inside transparent materials;
- Laser assisted etching in glasses;
- High throughput laser cutting and micromachining;
- Fast manufacturing and replication of microstructures by UV lithography and soft lithography.

Saulėtekio al. 15, LT-10224 Vilnius,
Website: www.femtika.lt

Evana Technologies
Founded: 2012
Director: Dr. Egidijus Vanagas
Employees: 5

The business of *Evana Technologies* is the commercialization of laser and optical technologies and the manufacturing of systems employing these technologies for industry. The main activities are the development of laser material processing technologies. At present, the company works on the development and manufacturing of OEM solutions for scribing sapphire and silicon carbide wafers for semiconductor industries.

Address: Mokslininkų St. 2A, LT-08412, Vilnius
Website: www.evanatech.com

Fiber Optic Devices Ltd.
Founded: 1994
Director: Piotr Levin
Employees: 91

Fiber Optic Devices Ltd. (FOD) is a complete fiber optic technology company offering a variety of products and services to the OEM and End-user markets. Founded in 1991, FOD is a recognized leader in partnerships in the design and manufacturing of Fiber Optic Components and Fiber Optic Test & Measurement solutions. FOD invests over 20% of revenue into R&D activities, creating new and innovative solutions for Components and Test & Measurement products. FOD continues to provide market leading features in compactness, cost-of-manufacturing, optical specifications and quality.

Address: Naugarduko St. 41, LT-03227, Vilnius, Lithuania
Website: www.fods.com

Geola Digital
Founded: 2003
Director: Dr. Stanislovas Zacharovas
Employees: 9

World-wide holography leader, *Geola* is the inventor of digital holographic printing using pulsed lasers, hologram copying with laser radiation slit method and other methods and instruments used in modern imaging and security holography. In addition, the company has developed customized pulsed lasers for holography. Since the lasers used for holography must possess exceptionally good output parameters, they can also be used for research purposes. Lasers manufactured by *Geola* are employed at such R&D centers as Rutherford Appleton Laboratory, Indira Gandhi Atomic Research Centre and others.
Geola is the only company in the world manufacturing pulsed RGB lasers with coherence length of more than 3 m. It is the supplier of pulsed holography studios, digital holographic printers for security and poster-sized image hologram printing, equipment for hologram copying using pulsed lasers. *Geola* is one of the two companies in the world printing poster-sized digital holograms, including holographic maps. *Geola* is the only company in the world producing security holograms with deep 3D image.

Address: Naugarduko St. 41, LT-03227, Vilnius, Lithuania
Website: www.geola.com

JSC „Holtida“
Founded: 2014
Director: Dr. Rasa Žostautienė
Acting director: Erika Rajackaitė
Employees: 2

JSC “Holtida” specializes in development of advanced optical security means. JSC “Holtida” was established in 2014 as spin-off company, which extends over 20 years of experience developed by a team of scientists in the field. This company accepted all experience and traditions to produce the holographic security labels. Establishment of the company was partly funded by the Agency for Science, Innovation and Technology (MITA) Innovative business promotion program (INOVEKS) and supported by Kaunas University of Technology, enabling the use of infrastructure of “SANTAKA” Valley, Science and Technology Center and the Technology Business Incubator.
JSC “Holtida” produces the original holographic labels for security, product authentication, and protection against counterfeiting:

- Formation of the original graphical image
- Formation of nickel shim (with the graphical view provided by the customer)
- Production of holographic security labels (provides tamper-evident protection at the highest level)
- Serial numbering of holographic labels and authorization
- Special marks
- Degradable polymer seals protected by holographic effects

The company has developed processes of holographic and kinematic images recording, recombining, master matrix fabrication, hot embossing, adhesive application, and integration to the document technique. These holographic processes are patented (patent number LT 4281 B).

Address: K. Baršausko St. 59-214, LT-51423 Kaunas, Lithuania
Website: www.holtida.lt

Integrated Fiber Optics
Founded: 20145
Director: Nikolajus Gavrilinas
Employees: 2

Integrated Fiber Optics develops and produces ultra stable, high extinction ratio, high optical power integrated fiber optics components and motorized rotating microoptics saturable absorbers of special purpose for mode-locked fiber oscillators.

Address: A. Juozapavičiaus St. 9A-110, LT- 09311, Vilnius
Website: www.ifoptics.com

Integrated Optics
Founded: 2012
Director: Evaldas Pabrėža
Employees: 18

Integrated Optics is a manufacturer of ultra-compact CW laser sources and power electronics. Established in 2012 company developed a series of ultra-compact CW diode and DPSS lasers called MatchBox and launched the product onto the market in 2013. In October 2015 the platform was upgraded to MatchBox2 and in 2016 it was supplemented with Q-Switch and combiner with 4 diode wavelengths. Thanks to the MatchBox2 Series Integrated Optics is named one of the top 3 Prism Awards 2017 finalists in the category of scientific lasers.
The MatchBox2 series includes 150 product configurations. Being very diverse in their technology all of them share the same enclosure, unified control interface (UART/USB), 5V operating voltage and a rich set of accessories.
As a series of diode and DPSS lasers, it is the most compact laser series in the world. The size of the enclosure is smaller than a regular matchbox, i.e. 30x50x16 mm3. The users adore its easy installation, compatibility throughout the series, ultimate compactness and low cost. Output parameters of most configurations rank among top 5 worldwide. The proprietary technology is used to make the lasers more affordable and most compact.
MatchBox2 lasers are used in such applications as Raman spectroscopy, fluorescence imaging, food sorting, gemstone sorting and medical diagnostics.

Address: Kalvarijų St. 125B, LT-08221, Vilnius, Lithuania
Website: www.integratedoptics.com

Lidaris
Founded: 2012
Director: Dr. Andrius Melninkaitis
Employees: 10

LIDARIS is a high-tech company, providing world-class optics characterization services focused on Laser-Induced Damage Threshold (LIDT). LIDT service helps to evaluate and select reliable optics vendors, optimize laser optics for high optical power applications and track daily manufacturing quality. Optics certification for laser-induced damage adds a unique selling point for your product in the market.
LIDARIS was founded as a start-up of Vilnius University Laser Research Center after more than 10 years of intense research in the field of laser damage phenomena. The company operates highly sophisticated measurement systems dedicated to accurate LIDT testing in accordance with currently existing international (ISO) standards. Other services and measurements are available on demand: total integrated scattering, cavity ring down, raster scan, chromatic dispersion, crystal efficiency, and transmission tests. Also, R&D projects based on original hardware and software solutions aimed at improving the quality of high power optics.
LIDARIS acts in the global market serving European, American and Asian companies - the leaders of today's laser market, including manufacturers and suppliers of optics and laser systems.

Address: Saulėtekio Ave. 10, LT-10223, Vilnius, Lithuania
Website: www.lidaris.com

Light Conversion
Founded: 1994
Director: Dr. Algirdas Juozapavičius
Employees: >170

Light Conversion is the leading manufacturer and global leader of tunable wavelength femtosecond laser systems. Femtosecond optical parametric amplifiers produced at Light Conversion take up to 80 % of the world market. The main products of the company are TOPAS and ORPHEUS series optical parametric amplifiers, diode-pumped femtosecond laser systems PHAROS and Carbide, time-resolved absorption and fluorescence spectrometers. In 2016 the company had more than 2000 optical parametric amplifiers and over 500 PHAROS or Carbide systems installed worldwide.
Light Conversion exports about 95 % of production. Its customers include industrial companies and research institutions in more than 40 countries. The largest part of the production is exported to Germany, Japan, the USA, China, and Great Britain. Currently, the company has 24 representatives in the European, North American and Asian countries dedicated to product sales and service. *Light Conversion* is one of the fastest growing companies in Lithuania.

Address: Keramikų St. 2B, LT-10233, Vilnius
Website: www.lightcon.com

Luvitera
Established: 2013
Director: Marius Vinciūnas
Employees: 1

The main activity of *Luvitera* is the development of innovative technologies and products for terahertz photonics, imaging and spectroscopy, both for scientific laboratories and industry. *Luvitera* produces broadband and wavelength-selective microbolometer arrays, to measure spatial terahertz beam profiles of various terahertz sources. The company offers an antenna-coupled titanium microbolometers and scanners as sensitive room temperature terahertz detectors and imagers. The company's components can be integrated into customized security and diagnostic systems.

Address: A. Goštauto St. 11, LT-01108 Vilnius, Lithuania
Website: www.luvitera.com

Optinės Dangos
Founded: 2003
Director: Kęstutis Niaura
Employees: 2

Optinės Dangos offers a wide range of unique optical coatings that match the highest quality standards. The company's products are used in lasers and other optical systems that are applied in a number of areas. *Optinės Dangos* uses in-house developed technologies allowing the company's products to achieve unprecedented reliability, innovativeness and meet very high technical requirements.

Address: A. Goštauto St. 12, LT-01104, Vilnius
Website: www.opticalcoatings.lt
Email: info@opticalcoatings.lt; odangos@gmail.com

Optogama
Founded: 2015
Director: Tadas Lipinskas
Employees: 8

Optogama designs, develops and manufacture custom laser related products and develops technologies for material processing, spectroscopy & analytical instrumentation, aerospace, security, vision and other applications.
Company products and services cover:

- R&D of 1,54 um "eye-safe" range laser sources
- Contract manufacturing of lasers and optical devices
- R&D of lasers for material processing, spectroscopy and medical applications
- Laser crystal materials development and manufacturing
- NIR and MIR Optical components and assemblies

Address: Mokslininkų St. 2A, LT-08412, Vilnius, Lithuania
Website: www.optogama.com;

Optonas
Founded: 2009
Director: Gintas Jakubėnas
Employees: 12

Optonas is a young, modern and fast growing Lithuanian company specializing in production of vacuum PVD coatings. It's a regional leader of MIR, FIR, VRM and crystal coatings.
The company deposits the ultimate performance and durability coatings on AGS, DKDP, LBO, LiIO3, ZGP, YAG, KTA, KTP, YVO4, ZnSe, RTP, KGW, CaF2, BBO and other problematic materials. *Optonas* offers customized production and provides customers with solutions tailored to their specific application. The coating materials include thin-film dielectrics, metals and semiconductor, ensuring highest quality and durability. They find applications in lasers devices and other optical systems.
The company is developing its own innovative thin-film coating technologies and is experienced in producing different types of coatings for broad-band dielectric mirrors, antireflective surfaces, beam-splitters, filters, polarizers, separators, and etc.
The coatings produced by *Optonas* are extremely robust and resilient under long-term laser illumination, mechanical impact and varying ambient conditions. Coatings for infrared, visible and ultraviolet spectral ranges from as low as 190nm to as far as 20000nm are available.

Address: Savanorių St. 235, LT-02300, Vilnius
Website: www.optonas.com

Optoteka, Rimkevičius and Gintautas, general partnership
Founded: 1991
Director: Remigijus Rimkevičius
Employees: 26

Optoteka is the developer and manufacturer of precision optical components from optical glasses and crystals. Such components are used in the manufacturing of optical equipment for research, industry, medicine, lighting, etc. Component production is based on the unique in-house technologies, created in 1993, which is constantly being developed. This enables manufacturing with extremely high quality. In addition to the main production, the company is the manufacturer of mechanical components for lasers. The company exports 40 % of its production. The ultrathin scatter-free optical crystals and linear optical elements are widely known in more than 30 countries worldwide. The company has a number of regular customers, and maintains long-term close collaborations.

Address: Kalvarijų St. 125, LT-08221, Vilnius, Lithuania
Website: www.optoteka.lt

Optronika
Founded: 2006
Director: Mindaugas Stankevičius
Employees: 6

Optronika is the producer of RGB laser projectors for industry and advertisements, unique shutters for laser micromachining, chillers for research equipment, optical analyzers of cleaning quality and freezing point of liquids and other spectrometric equipment. Currently, *Optronika* is involved in a cluster project developing a new generation laser-based orthopedic devices and energy-efficient building solutions. The company also manufactures laboratory and education equipment for research institutions. The company is also the largest provider of laser advertisement and illumination services for events, exhibitions, and concerts.

Address: Kalikstiškės, Maišiagala Township, LT-14247, Vilnius Distr., Lithuania
Website: www.optronika.lt

Oriental Technology Solutions
Founded: 2015
Director: Algirdas Rukšėnas
Employees: 2

Oriental Technology Solutions offers laser machines for:
- Marking, using fiber, CO2, DPSS lasers,
- Metal welding, using YAG and fiber lasers,
- Metal sheet and pipe cutting, using fiber and CO2 lasers with 500-6000 W power,
- Cutting of plastics, wood, paper, leather, textile materials using CO2 lasers.

Company manufactures the accessories and components for supplied machines, provides laser equipment integration services into the user manufacturing lines, warranty and post-warranty services. Consulting is offered in the field of technological application of lasers.
Research and tests are provided in the company application laboratory.
Company main partners are Wuhan Huagong Laser Engineering Co., United Winners Laser Co. , Wuhan Golden Laser Co., China P.R., MLT Micro Laser Technology GmbH, Germany.

Address: Mokslininkų St. 11, LT-04812, Vilnius, Lithuania
Website: www.orientaltechnology.eu

Quantum Light Instruments
Founded: 2014
Director: Andrius Rinkevičius
Employees: 3

Quantum Light Instruments Ltd (QLI) is designing and producing diode pumped, air-cooled, Q-switched Nd:YAG and Nd:YLF lasers and laser systems for wide range of applications that require low pulse repetition rate and high pulse energies.
Quantas series lasers are the replacements of traditional complicated Q-switched, water cooled laser systems and provide much longer operating life time with much smaller cost of ownership. It is a cost-effective solution for a wide range applicati-

ons including LIBS, PLD, MALDI, LIDAR, PIV, LCD repair, Semiconductor Processing and many others. Lasers controlled via built-in Ethernet port trough a web-server, with Wi-Fi adapter available as an option. It allows the users to monitor and control the lasers remotely. The company exports 95 % of its production. QLI lasers are intensively used in OEM integrator systems with the positive feedback. Company constantly invests in the development of the new lasers which can be used in harsh enviroments.

Address: Mokslininkų St. 6A-351, LT-08412, Vilnius, Lithuania.
Website: www.qlinstruments.com

Sprana
Founded: 2012
Director: Dr. Raimundas Steponavičius
Employees: 6

We are experts in applied spectroscopy (UV-Vis-NIR-MIR) providing Process Analytical Technology (PAT) solutions for on-line/in-line/at-line monitoring and analysis of industrial processes (product streams). We currently offer products (analyzers) for on-line/in-line colour analysis of liquid product streams. They include petroleum products (paraffin wax, oil, diesel, naphtha, etc.), edible oils, beers and malts, beverages, chemicals etc. We also work with on-line/in-line quantitative analysis of liquid fertilizer such as Urea Ammonium Nitrate (UAN), Urea with additives and folio fertilizer (total content of ammonium N, NO3, NH2, H2O, concentration of additives etc.), and at-line quantitative analysis of solid mineral fertilizer such as mono and di ammonium phosphate and calcium ammonium nitrate (concentration of N, P, H2O). We also do quantitative analysis and characterization of light scattering media such as polymer suspensions applying advanced spectroscopic methods and techniques. Research and development of new analytical instrumentation/solutions (process analyzers) along with multivariate calibration is an integral part of our business.

Address: Mokslininkų St. 6A, LT-08412 Vilnius
Website: www.sprana.eu

Standa
Founded: 1987
Director: Dr. Michail Berba
Employees: 140

Standa is one of the largest European companies designing and manufacturing high-precision optomechanical components for science, education and industry. The company also develops and manufactures DPSS sub-nanosecond SLM microlasers for research, and integrates them in biological, chemical and medical spectroscopic equipment.
The main products of the company are high-precision mechanical and optomechanical devices (nanometric precision motorized and manual positioners of optical components, translation and rotation stages, motion control for vacuum, fine adjustment screws, micrometer screws), optical honeycomb tables, honeycomb optical tables and vibration isolation equipment (e.g. for atomic force microscopes), light power and energy meters, picosecond pulsed lasers.
Standa was founded in 1987, and currently employs 140 staff. More than 80% of production is exported to ca. 60 countries, the main customers being research institutes, universities, military and industrial research facilities. About 15% percent of sales go to other Lithuanian laser companies; the products of Standa are widely used in the research labs of Lithuanian universities and research institutes.

Address: Švitrigailos St. 4–39, LT-03222, Vilnius, Lithuania
Website: www.standa.lt www.standaphotonics.com

Teravil
Founded: 2006
Director: Dr. Andžej Urbanovič
Employees: 5

Teravil is a developer and manufacturer of the terahertz (THz) range spectroscopic systems and components. Company's competence lies in developing and manufacturing of THz radiation spectroscopy systems based on solid state or fiber lasers and photoconductive antennas. Currently, the company manufactures and sells THz radiation sources and receivers, for use with ~800 nm and ~1000 nm wavelength lasers, and complete THz spectroscopy systems based on these devices. Nearly 100% of the production is exported.

Address: Savanorių ave. 235, LT-02300, Vilnius, Lithuania
Website: www.teravil.lt

Workshop of Photonics
Founded: 2007
Director: Eugenijus Kurtinaitis
Employees: 19

Workshop of Photonics (brand of the company Altechna R&D) is all about laser micromachining. We develop instruments and solutions for laser micromachining tasks: from feasibility studies to customized optical modules and from electronic devices to laser machines. Our services are targeted to both industrial and academic customers.
Workshop of Photonics key competencies:

- Feasibility studies on femtosecond laser micromachining
- Development of custom femtosecond laser micromachining workstations and optical modules
- Small scale production (job shop) in the area of laser micromachining
- Laser system automation software

The products made by *Workshop of Photonics* are used in industry (to increase the efficiency and precision of manufacturing), in medicine (to enhance the functionality of medical devices), and in the scientific research (different photonic applications).
The growth of our competence is fueled by the culture of open innovation and partnership with the local laser sector companies and worldwide partners. Workshop of Photonics is constantly working on projects connecting scientific inventions with the industry needs.

Address: Mokslininkų St. 6A, LT-08412 Vilnius
Website: www.wophotonics.com

Altos Photonics Inc.
Country: USA
Founded: 1995

Altos Photonics, Inc. offers lasers & laser systems, optics, crystals, opto-electronics, and opto-mechanical components to research institutes and industrial customers.

Since 1995, we have worked with our customers and suppliers to enable groundbreaking technologies, innovative products, and cutting-edge research. We match of matching our clients' application requirements by supplying the products from our partners EKSPLA, Light Conversion, EKSMA Optics, and Standa.

Our pulsed lasers range from high-energy systems used in high-energy physics and non-linear spectroscopy to DPSS systems used in micro-machining and ultrafast spectroscopy applications. Our femtosecond, mode locked, and Q-switched lasers and tunable OPO/OPA systems are used by leading scientists in their quests to understand chemical processes and interactions, biologic processes, and to understand basic questions of physics.

Passive laser components include UV and IR optics, non-linear crystals (BBO, KTP, ZGP, KYW, KGW, etc), optical mounts, and motorized stages & positioners. Opto-Electronic products include high energy flashlamp drivers, Pockel's cell drivers, laser pump chambers.

Together with our outstanding customers, we are working to improve our environment and human health by enabling advances in clean energy, bio-medical polymers, heart stent manufacturing, battery technology, cancer treatment, eye cataract surgery, and in understanding of environmental interactions related to climate change.

We actively encourage laser safety by promoting laser safety products and by participating in ANSI Z136 the committee for laser safety, working to define and implement standards for the safe use of lasers.

Altos Photonics is managed by Lucian Hand, president and shareholder, together with major shareholders UAB Light Conversion and UAB EKSPLA.

Address: 201 South Wallace, Suite B-2C, Bozeman, MT 59715, USA
Website: www.altosphotonics.com

Light Conversion – China
Country: China
Founded: 2016

Light Conversion – China was opened in Shenzhen – technology capital in China in 2016. During a few recent years, the sales of Light Conversion products in China saw a significant growth. The growing number of scientific and industrial customers created a need to be closer to the clients for faster communication and better availability of technical support. Currently Light Converssion – China is a service center focusing on aftersales customer support. We provide fast on-site service and support of Pharos and Carbide femtosecond lasers and different models of Orpheus OPA systems. The company also has a service laboratory, where most common laser problems can be solved without sending the equipment back to the factory in Lithuania. As a number of customers in China continues to grow, we plan to expand our activities to include the advertisement and sales of Light Conversion's products in Chinese market.

Address: Room 1106, Gongyuandao Building B, 26 Dengliang Rd, Nanshan district, Shenzhen 518054, China
Website: www.lightcon.cn

Shanghai EKSMA Laser Technologies Co, Ltd.
上海爱恪斯码激光技术有限公司
Country: China, P.R.
Founded: 2016 by UAB EKSMA

Shanghai EKSMA Laser Technologies Co, Ltd. is the successor to the EKSPLA Shanghai Representative Office. The purpose of this company is to expand sales, provide technical support and service to customers from mainland China. We service the industrial lasers and opto-electronics made by EKSPLA and distribute the laser components – laser optics, crystals and electro-optical devices made by EKSMA Optics.

The success of previous representative office led to the upgrade to a legal entity capable of providing better sales and service support to Mainland China and other customers in the region.

The sales of picosecond and fiber lasers and reliable, high-quality laser components are expected to increase further due to the concentration of advanced manufacturing industries such as electronics, medical devices, transportation vehicles, new energy solutions and other fields where high power lasers or ultrafast solid-state laser based micro-processing equipment is used.

Besides managing the sales of EKSPLA and EKSMA Optics products *Shanghai EKSMA Laser Technologies Co, Ltd.* provides marketing support to other Lithuanian partners or associated companies.

Address: SHANGHAI EKSMA LASER TECHNOLOGY CO., LTD. Suite 3008, Bldg 4, No.18 Huangyang Road, Pudong, Shanghai, 201206, P.R. China
Websites: www.eksplachina.cn ; www.eksmaoptics.cn

Sibirskij Monokristall – EKSMA
(Сибирский монокристалл – ЭКСМА)

Country: Russia
Founded: 1999

Sibirskij Monokristall-EKSMA is a joint Lithuanian-Russian venture. Almost 50 % of the shares of this company are owned by the company EKSMA. The company is a manufacturer of nonlinear optical and laser crystals. The manufacturing is based on unique in-house developed crystals growth and further processing technologies. The company has an extensive experience in crystals characterization. A major part of the production of the company is marketed and sold through EKSMA Optics, another company of the EKSMA Group. Sibirskij Monokristall-EKSMA closely collaborates with the Institute of Geology and Mineralogy of the Russian Academy of Sciences, and the Institute of Applied Physics.

Address: Ul. Russkaya 43, Novosibirsk, Russia


LIETUVOS LAZERIŲ ASOCIACIJA
LITHUANIAN LASER ASSOCIATION


VILNIAUS UNIVERSITETAS
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CENTER
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AND TECHNOLOGY


Altechna
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EKSMA


EKSMA
OPTICS


EKSPLA


elas


femtika


HOLTIDA


integrated
optics


LIDARIS
LIDT Service

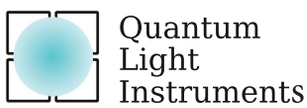

LIGHT
CONVERSION


OPTOGAMA


OPTIDA
COATINGS FOR OPTICS
ALTECHNA GROUP


Optical
thin film
coatings
optonas


Optronika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