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Professor Juozas Vidmantis Vaitkus and the first Lithuanian laser on its 60th anniversary

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ABSTRACT

The objective of this article is to reconstruct the development of Lithuanian laser science on the 60th anniversary of the first laser constructed and fired at Vilnius University in 1966, with particular attention to the role of Professor Juozas Vidmantis Vaitkus. Historical and published sources show that the first Lithuanian laser was developed for semiconductor research and initiated laser-based materials studies at Vilnius University (VU). Under Vaitkus's scientific leadership, this research expanded into international research on radiation-hard semiconductor materials and detectors at the European Organization for Nuclear Research (CERN), as well as interdisciplinary applications in laser medicine, biomedical optics, and personalized optical diagnostics. The establishment of the Institute of Applied Sciences at VU in 1992 helped preserve and develop interdisciplinary collaboration between physics, engineering, chemistry, computer science and medicine during the transition from the Soviet research system. These activities contributed to the development of laser surgery, fluorescence spectroscopy and optical diagnostic methods, alongside education and international scientific cooperation. The first Lithuanian laser, fired on Vaitkus's initiative in 1966, marked the beginning of continuous development from fundamental semiconductor research to laser-based materials science and the establishment of a Lithuanian photonics school with broad applications, including medicine. Its 60th anniversary in 2026 also marks the vision, determination and scientific leadership that laid the foundations for these developments and contributed to Lithuania's international achievements in science, technology and medicine.

Key words: laser science; laser medicine; biomedical optics; photonics; Lithuania.

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Introduction

Lithuania has developed a distinctive international profile in laser science, photonics, and laser medicine, rooted in Vilnius University (VU), founded in 1579, and in the development of modern physics during the second half of the 20th century. Professor Juozas Vidmantis Vaitkus[a] was one of the scientists who connected fundamental semiconductor physics with laser-based materials research and, through interdisciplinary and international cooperation, with biomedical applications and the training of a new generation of researchers.

The origins of Lithuanian laser science

In 1962, Professor Povilas Brazdžiūnas of the Department of Experimental Physics at VU recognized the emerging importance of quantum electronics and supported the education of young Lithuanian physicists in this field. Students, including Irena Gulbinaitė, Evaldas Maldutis and Algis Petras Piskarskas,[b] were sent to Lomonosov Moscow State University (USSR) to study quantum electronics and wave physics. Piskarskas was the first to return to VU, in 1968, joining the Department of Radiophysics. There, he established a research group that developed a laser in 1969. Other physicists trained in Moscow later joined the group, contributing to both the education of students and the advancement of research. The appointment of laser specialists at the VU Laser Research Center and the establishment of the Department of Quantum Electronics, both led by Piskarskas, created an important foundation for laser research and education at the Faculty of Physics. Piskarskas's activities contributed substantially to the successful development of laser science and the laser industry in Lithuania.

During the early 1960s, limited access to laser equipment in the Soviet Union compelled Lithuanian researchers to build their own instruments and technical base. The historical context of these developments is also documented in contemporary memoir material.[1,2]

Building the first laser in Lithuania

Juozas Vidmantis Vaitkus grew up in a family of teachers and graduated with honors from VU in December 1963. He began postgraduate studies in January 1964 in the Department of Semiconductor Physics at the Faculty of Physics of VU under Professor Jurgis Viščakas.[c]

Vaitkus's doctoral research required intense, short-duration light pulses, leading him to investigate Q-switching and the use of lasers to generate high-intensity nanosecond pulses. The idea of applying a laser to semiconductor photoconductivity arose while he was reviewing a journal of the USSR Academy of Sciences that reported the availability of such lasers in the laboratory of Professor N. G. Basov at the Lebedev Physical Institute of the Soviet Academy of Sciences (FIAN). Access to international scientific journals by researchers in the Soviet republics was delayed, in some cases by up to 2 years, because publications had to become available through Russian-language channels.

Through VU colleague Ignas Gaska and his contacts in Moscow, Vaitkus gained access to Professor Nikolay G. Basov's laboratory at FIAN, where he proposed experiments on semiconductor photoconductivity. While the necessary measuring equipment was being constructed in Vilnius, Basov was awarded the 1964 Nobel Prize in Physics together with Alexander Prokhorov and Charles H. Townes. Basov nevertheless continued to support the young Lithuanian researcher.

In 1965, Vaitkus returned to FIAN with a measuring sys-

[a] Academician, Professor Juozas Vidmantis Vaitkus: Fellow of the Institute of Physics (UK; FInstP); Honorary Visiting Professor at the University of Glasgow (1996-2006); member of the European Physical Society and Lithuania's national representative on the EPS Governing Board (professional qualifications); Vice-President of the Lithuanian Physical Society (2003-2007) and President (2007-2018); Member of the Lithuanian Materials Research Society; Institute of Electrical and Electronics Engineers (IEEE) Senior Member (2021); Member of the International Society for Laser Surgery and Medicine (ISLSM), serving as Secretary General (2013-2015); Chancellor of the Lithuanian Progress Prize.

[b] Academician Professor Algis Petras Piskarskas: Physicist in quantum electronics and wave physics; Baccalaureate and doctoral studies at Lomonosov Moscow State University (1962-1968); Leader of the VU group that developed Lithuania's first picosecond multicolor parametric laser in the early eighties; Director of the Laser Research Center (1983-1988); Head of the Department of Quantum Electronics (1978-2012); Recipient of the Alexander von Humboldt Research Award, the USSR and Lithuanian Science Prizes, the European Physical Society Quantum Electronics Prize, and the Commander's Cross of the Order for Merits to Lithuania.

[c] Academician Professor Jurgis Viščakas: Vaitkus's doctoral supervisor; Head of the Department of Semiconductor Physics at the VU Faculty of Physics (1960-1970); Dean of the Faculty of Physics, VU; Director of the Institute of Physics of the Lithuanian Academy of Sciences (1977-1988); Lithuanian SSR State Prize Laureate (1970); Honored Scientist of the Lithuanian SSR (1977).

tem designed and built by Vytautas Mudėnas at VU. Using this system, he investigated cadmium selenide (CdSe) photoconductivity under laser excitation and demonstrated nanosecond-range relaxation times relevant to optoelectronic response. Basov also agreed to host VU student Remigijus Baltramiejūnas[d] for training in laser construction. Basov subsequently provided Vaitkus's team with a laser head consisting of an elliptical reflector designed for a ruby crystal and a cylindrical flashlamp. A suitable ruby crystal was obtained from a specialized factory in Armenia, while other optical, mechanical, and electronic components were acquired or made through scientific contacts and university workshops. At this time, Vaitkus was simultaneously a doctoral student and a senior research fellow at the Specialized Laboratory of Semiconductor Physics. He supervised Baltramiejūnas's diploma research, and younger students also participated in constructing the first Lithuanian laser.

The first Lithuanian laser was constructed and fired in the Department of Semiconductor Physics, Faculty of Physics, VU, in early 1966. It was built for semiconductor research. As experimental objectives expanded, successive laser systems with different optical characteristics were developed for specific materials-research tasks. Piskarskas provided technical advice through correspondence and sent amplifier drawings to Vaitkus, which contributed to the development of subsequent laser systems.

The beginning of laser research in Lithuania

To analyze the experimental spectral data, Vaitkus collaborated with mathematician Zenonas Norkus. Their work contributed to the first scientific publications based on the new laser experiments. In June 1966, Vaitkus presented results on the photoconductivity of CdSe monocrystals excited by ruby and neodymium lasers at an All-Union conference in Kyiv (Ukraine); in September, he reported Q-switched laser studies of polycrystalline semiconductor layers at an electrography conference in Vilnius.

These presentations marked the beginning of documented laser-based materials research in Lithuania. In 1967, Vaitkus defended his PhD (Candidate of Sciences) dissertation on the kinetics of photoconductivity in CdSe monocrystals and layers. In 1978, he defended his Doctor of Sciences dissertation in Kyiv, entitled *Nonlinear Photoconductivity and Related Nonequilibrium Phenomena in Semiconductors under Intense Laser Excitation*. The degree, awarded in 1979, recognized his contributions to semiconductor physics and laser-based materials research.

Medical technology and laser medicine

Vaitkus's interest in medical technology developed through collaboration with clinicians and through his family connections with medicine. His father-in-law, Dr Povilas Steponėnas, Head of the Department of Obstetrics and Gynecology at VU, encouraged cooperation between physicists and physicians. This cooperation led to the development of thermocouple belts, thermocrystal materials, and fetal electrocardiography electrodes for obstetric diagnostics.

Vaitkus entered laser medicine in 1977, when Academician Nikolay Basov recommended his team to Professor Jurgis Brėdikis (Kaunas Medical Institute) for the development of a surgical laser for cardiac applications. A cooperation agreement led to the construction of a ruby laser by a group from the Department of Semiconductor Physics at VU, headed by M. Petrauskas. In 1983, the system was used in a pioneering clinical procedure for laser-assisted myocardial revascularization, in which an optical fibre was employed to restore blood flow following myocardial infarction. An improved Nd:glass laser was developed in 1985, while subsequent studies investigated the use of lasers to correct cardiac electrical conduction.

During the 1980s, Lithuania also strengthened its laser-technology infrastructure. Under Academician Jurgis Viščakas, the Institute of Physics of the Lithuanian Academy of Sciences made laser research a strategic priority. In 1981, Dr. Sc. R. Kanapėnas established the Laser Mechanics and Technology Sector at the Institute, which developed the portable LMP-010 laser-magnetic therapy device in 1983. Its successor, the LMP-010M, was later

[d] In 1968, Baltramiejūnas used a self-constructed laser system in his diploma research to excite semiconductor samples, with their optical response recorded spectroscopically. After returning to Vilnius in 1968, Piskarskas's group helped Baltramiejūnas obtain specialized laser components through contacts established in USSR. Baltramiejūnas later constructed a first laser at Charles University in Prague (Czech Republic) within the framework of university collaboration. He subsequently led the Laboratory of Nonlinear Spectroscopy of Condensed Matter, defended his PhD and Doctor of Science dissertations, became Professor, and served as Director of the Institute of Physics (1989-1992). He received the Lithuanian SSR State Prize in 1985 for research in solid-state spectroscopy.[3]

patented and, following clinical validation and European certification, entered commercial production.

Interdisciplinary research and biomedical optics

In 1985, on Vaitkus's initiative, an interdisciplinary research team was established. Aurelija Vaitkuvienė, a physician with a PhD in obstetric ultrasound diagnostics, joined the program and performed preclinical studies of an Nd:YAG surgical laser-coagulator Medula at the VU Laser Research Center led by Piskarskas. From 1987, results on laser-tissue interaction were presented at international laser-medicine conferences. In 1989, Vaitkuvienė became the first Lithuanian to receive a laser surgery diploma from the Wensky Laser Center in the US.
Based on earlier experience in laser development for cardiac surgery, Vaitkus mediated the first clinical trial in gynecology of the Lithuanian surgical laser-coagulator Medula in 1990. After successful trials in gynecology and oncology, the device received the first medical-device approval certificate in independent Lithuania in 1991 and was presented at the FIGO World Congress in Singapore.

Optical diagnostics and personalized medicine

Following the use of an advanced laser spectroscopy device constructed by Professor V. Gavryushin of the Department of Semiconductor Physics, a portable fibre-optic fluorescence spectroscopy system was developed at the Institute of Applied Sciences and applied to a broad range of biological materials, including amniotic fluid, cervical mucus, cervical smear specimens, endometrial tissue, and intervertebral-disc biopsies. *In vivo* examinations of cervical epithelium were performed using devices developed by Swedish and US teams.[4-9]

International clinical trials

Following Aurelija Vaitkuvienė's internships at the University Clinic of Malmö and the Laser Medicine Center of Lund University (Sweden), a strong scientific partnership developed between the Swedish teams led by Professors Sune Svanberg and Katarina Svanberg and the Lithuanian teams led by Juozas Vaitkus and Aurelija Vaitkuvienė. A formal cooperation agreement was signed, and patient trials were conducted in Vilnius in 1996-1997 using a diagnostic laser developed at the Lund Laser Center (Figure 1).[4]
The joint work attracted the attention of Science & Technology International of Honolulu (Hawaii), which was seeking a European location for the next phase of a clinical program. A tripartite Lithuania-Sweden-US agreement was subsequently signed. Despite differences among the clinical trial and regulatory systems of the three countries, a Phase 2 study of cervical tissue in 111 Lithuanian women was successfully completed at VU Institute of Applied Sciences and Vilnius City University Hospital. The study used hyperspectral imaging and point-monitoring techniques. Its results generated international publications, and researchers from Lund University used the Vilnius data in doctoral dissertations.[5] The final phase was later completed in South America, contributing to the clinical evaluation of a hyperspectral diagnostic imaging device for cervical cancer prevention.

Director of the Institute of Applied Sciences at Vilnius University

In 1992, Vaitkus became Director of the newly founded Institute of Applied Sciences at VU. During the collapse

Figure 1. From left to right: Professors Katarina and Sune Svanberg, Professor Juozas Vidmantis Vaitkus, and Associate Professor Aurelija Vaitkuvienė at Laser Florence. Photograph from the author's personal archive.

of the Soviet research system, the Institute preserved interdisciplinary research in physics, engineering, chemistry, computer science, and medicine. Its Laser Surgery Department, led by Vaitkuvienė, expanded from surgical laser technologies into biomedical optics and personalized optical diagnostics.

Four medical dissertations were prepared in collaboration with the Laser Surgery Department (later the Department of Biomedical and Information Technologies): one surgical, two diagnostic, and one combining surgical and diagnostic research. The doctoral researchers were also co-authors of the corresponding publications.[6,8-10]

Under the supervision of laser physicists, Aurelija Vaitkuvienė's textbook Fundamentals of Laser Surgery was published in 1994 and supported specialized courses for physicians in laser surgery and safety, delivered jointly by the Faculties of Physics and Medicine (1992-1996).

In 2000, Vaitkuvienė summarized the Department's scientific results in the monograph *Minimally Invasive Gynaecology*.[11]

Educational legacy and scientific recognition

Throughout his career, Vaitkus supervised 31 successful doctoral dissertations in physics. Physicist Egidijus Auksorius[e] began postgraduate research under Vaitkus, participated in diagnostic research at the Laser Surgery Department, and later continued doctoral research in biomedical optics at Imperial College London (UK).

Vaitkus spent 32 years working in science during the period of Soviet occupation and 32 years in independent Lithuania, witnessing and contributing to the transformation of Lithuanian science. In 2003, he was an invited speaker at the VIII Zemering Forum in Brussels (Belgium), presenting Lithuania's transition from Soviet-era science to European and international research programs. Together with members of his research teams, he received the USSR State Prize, the Lithuanian SSR State Prize and three Lithuanian Science Prizes.[1] In 2021, he was awarded the Commander's Cross of the Order of the Lithuanian Grand Duke Gediminas for significant contributions to Lithuanian science.[1] In 2025, Vaitkus and colleagues in the Compact Muon Solenoid Collaboration at the Large Hadron Collider at the European Organization for Nuclear Research (CERN) were recognized through the Breakthrough Prize in Fundamental Physics.

CERN leadership and international recognition

Vaitkus served as VU's and Lithuania's official representative to CERN; from 2002 to 2005, he was convener of the "New Materials" research line of the CERN RD50 Collaboration; from 2003 to 2007, he coordinated the gallium nitride (GaN) research line; and from 2007 to 2020, he served as Deputy Chair of the CERN RD50 Collaboration Board (Figure 2).

VU became an official participant in CERN's RD50 and RD39 research programs. Vaitkus's research in this area addressed radiation-hard semiconductor materials and detectors, including new materials for radiation-hard semiconductor detectors and semi-insulating GaN for particle detection.[16-19] Together with Ambassador Rytis Paulauskas, then Director of the Information and Public Relations Department at the Ministry of Foreign Affairs, he initiated Lithuania's Associate Membership process with CERN in 2016.

To support this direction, the Experimental Nuclear and

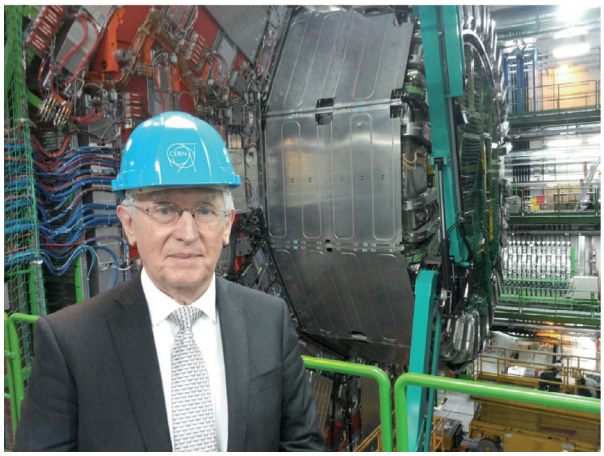

Figure 2. Professor Vaitkus at the CERN ATLAS experiment. Photograph from the author's personal archive.

[e] Dr. Auksorius later held research positions at Harvard Medical School (USA), ESPCI Paris (France), and the Institute of Physical Chemistry in Warsaw (Poland). Since 2020, he has been a Principal Investigator at the Center for Physical Sciences and Technology in Vilnius. His research includes super-resolution STED microscopy, fluorescence-lifetime and label-free imaging, and Fourier-domain full-field and dynamic optical coherence tomography for *in vivo* retinal, corneal, and tissue imaging.[12-15]

Particle Physics Center was established at VU in 2017, with Vaitkus serving as interim Chair.[1]

Figure 3. Professor Juozas Vidmantis Vaitkus among members of the Scientific Board of Laser Florence 2008 and the International Academy of Laser Medicine and Surgery. Photograph from the author's personal archive.

Figure 4. Professor Juozas Vidmantis Vaitkus presenting a Young Scientist Award at Laser Florence 2008, with conference initiators and organizers, Professors Leonardo Longo and Izoak Kaplan. Photograph from the author's personal archive.

International leadership and the 2013 World Laserology Congress in Vilnius

When laser spectroscopy in endometrial tissue was presented at the Laser Florence Congress of the International Academy of Laser Surgery and Medicine in 2000, gynecologist A. Vaitkuvienė was appointed a founding member of the International Academy for Laser Medicine and Surgery and a member of its Scientific Board. Later, Academician Professor J. V. Vaitkus was invited to present laser physics and diagnostics for physicians and became the second board member from Lithuania. Four young Lithuanian researchers in medicine and biophysics received Young Researcher Awards at Laser Florence (Figures 3 and 4).
J. V. Vaitkus was invited to organize the International Laser Therapy Association Congress and the Assembly of World Laser Medicine Associations in Vilnius. The event reflected the international standing of Lithuanian laser science and Vaitkus's interdisciplinary leadership.[20]

Conclusions

The successful firing of Lithuania's first laser in 1966 established a new experimental capability for semiconductor and materials research. In the decades that followed, Lithuanian laser science diversified into specialized research systems, biomedical applications, optical diagnostics and photonics, supported by increasingly broad collaboration among physicists, engineers, physicians, and international research groups. The 60th anniversary in 2026 marks both Lithuania's first laser firing and the vision, determination, and scientific leadership that laid the foundations of modern Lithuanian photonics and contributed to international achievements in science, technology, and medicine.

Conflict of interest: the author, spouse of Professor Juozas Vidmantis Vaitkus, declares that she has no other competing interests.

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