IEEE Milestone Dedication Event

"Single-Mode Semiconductor Laser for Long-Wavelength Optical Fiber Communication"

"Vertical-Cavity Surface-Emitting Laser"

October 28, Tuesday 2025
Ookayama Campus, Institute of Science Tokyo

記念碑の設置後に差替

IEEE Milestone Dedication Event
"Single-Mode Semiconductor Laser for Long-Wavelength Optical Fiber Communication"
"Vertical-Cavity Surface-Emitting Laser"
October 28, Tuesday 2025
Ookayama Campus, Institute of Science Tokyo

Dedication Ceremony | 13:30–14:10
Venue: Digital Multi-Purpose Hall, West Bldg. 9, Ookayama Campus, Institute of Science Tokyo
Organizer: IEEE Tokyo Section
Chair: Dr. Akinori Nishihara (IEEE Region 10 Director (2019-20))

・Opening Remarks: Prof. Toshio Hiramoto (Chair, IEEE Tokyo Section)
・Remarks from the Presenter:
Prof. Kathleen A. Kramer (IEEE President & CEO)
・Presentation of the Commemorative Plaques
・Acceptance Speech:
Dr. Naoto Ohtake (President & CEO, Institute of Science Tokyo)
・Guest Congratulatory Addresses:
Mr. Takashi Fuchigami
(Director-General, Research Promotion Bureau, MEXT)
Dr. Hideo Kuwahara (Honorary Fellow, Fujitsu Ltd.)

Photo Session | 14:10–14:20

Commemorative Lectures | 14:20–15:20
Organizer: Institute of Science Tokyo
Co-organizers: IEEE Tokyo Section TPC, Kuramae Alumni Association
Chair: Prof. Fumio Koyama (Institute of Science Tokyo)

・“The Significance of IEEE Milestones”:
Dr. Hiroshi Suzuki (IEEE Tokyo Section History Committee Chair (2019-22))

・“Single-Mode Semiconductor Lasers that Enabled Long-Wavelength Optical Fiber Communications- the Internet’s Backbone: Dynamic Single-Mode Lasers”:
Dr. Yasuharu Suematsu (Honorary Professor, Institute of Science Tokyo)

・"VCSEL: From Invention and IEEE Milestone to Expanding Applications in Optical Interconnects, Sensing, and Beyond":
Dr. Kenichi Iga (Honorary Professor, Institute of Science Tokyo)

Reception | 15:40–17:10
Venue: Tsubame Terrace, Halls A & B
Organizer: Institute of Science Tokyo
Co-organizers: Kuramae Alumni Association, Sponsor: Tsurugi Photonics Foundation
Chair: Prof. Hiroyuki Uenohara (Institute of Science Tokyo)

- Address: Dr. Kazuya Masu (Former President, Tokyo Institute of Technology, Director, G-QuAT (AIST))

- Congratulatory Remarks and Toast: Prof. Connie Chang-Hasnain (Professor Emeritus, UC Berkeley, Chairperson and founder of Berxel Photonics Co. Ltd.)

- Social Gathering

- Closing Address: Dr. Yuichi Tohmori (Representative Director, Tsurugi Photonics Foundation)

About IEEE
IEEE is the world's largest professional technical organization dedicated to advancing technology for the benefit of humanity. As of 2025, IEEE comprises over 486,000 members in more than 190 countries, with more than 67 percent from outside the United States (source: https://www.ieee.org/about/at-a-glance). IEEE encompasses professionals across fields such as electrical, communications, computer science, engineering, and related disciplines. It publishes a vast portion of the world's engineering literature, including hundreds of peer-reviewed journals, conference proceedings, and industry standards. Although the organization is today universally known simply as IEEE, the name originally derived from the Institute of Electrical and Electronics Engineers.

What Is the IEEE Milestone Program?
The IEEE Milestone Program honors historically significant technical achievements in electrical, electronic, and computing engineering that have left a lasting mark on society. Unlike individual awards, a Milestone recognizes a specific achievement in its original location, commemorated with a bronze plaque for public visibility. Achievements must be over 25 years old, and demonstrate documented technical excellence and profound industrial or societal impact. Proposals undergo rigorous peer review before approval by the IEEE Board of Directors (sources: ETHW, Wikipedia).

Why Milestones Matter
Milestones help preserve and communicate engineering heritage by making innovation visible and tangible. They transform historic breakthroughs into educational experiences, strengthen institutional pride, and inspire future engineers by connecting them to the roots of modern technology.

Past IEEE Milestone Examples
The IEEE Milestones program has recognized about 260 landmark achievements worldwide (≈263 as of 2024), including roughly 46 in Japan.
Exemplars span the backbone of modern life: the transistor (modern electronics); the first integrated circuit (microchips); ARPANET/TCP/IP (birth of the Internet); Ethernet (local networking); the semiconductor laser (optical-fiber communications); 193-nm photolithography (chip scaling); PageRank and the birth of Google (web search); Tokaido Shinkansen's ATC (safe high-speed rail); Seiko's electronic quartz wristwatch (precision timekeeping); and the QR Code (ubiquitous IDs and mobile payments). Together they show how electrical and information engineering has repeatedly reshaped industry, infrastructure, and daily life.

Today's IEEE Milestone Dedication at Institute of Science Tokyo
On October 28, Institute of Science Tokyo will host the dedication of two IEEE Milestones that have profoundly contributed to today's digital infrastructure:

- "Single-mode semiconductor lasers for long-wavelength optical fiber communications": These lasers enabled efficient, high-capacity data transmission over optical fibers, underpinning global Internet backbone networks.
- "Vertical-Cavity Surface-Emitting Lasers (VCSELs)": Distinguished by low power consumption, wafer-level manufacturability, and array compatibility, VCSELs are central to optical interconnects within data centers, and power devices such as laser printers, 3D sensors, and smartphones.

These achievements are celebrated for enabling critical infrastructure—from intercontinental communication networks to high-speed datacenter interconnects. Today's dedications join earlier IEEE Milestones for 'ferrites' and 'quartz crystal oscillators.' With four plaques in total, Institute of Science Tokyo now holds the largest number of IEEE Milestones of any university in Japan, and ranks second worldwide after MIT (nine recognitions, including Lincoln Laboratory).

How IEEE Milestones Are Created

The Milestone nomination process is community-driven. IEEE local sections, universities, and industry partners jointly prepare evidence-based documentation and a narrative accessible to non-specialists. Subject-matter experts and the IEEE History Center review proposals; upon approval, a bronze plaque is cast and installed. The dedication ceremony brings together IEEE leadership, institutional representatives, and distinguished guests to celebrate the achievement and its enduring legacy.

Great Figures at the IEEE Milestones in Telecommunications and Informatics

(Source: Prof. Yasuharu Suematsu's Commemorative Lecture
Pictures by Courtesy of Wikimedia Commons)

Single-Mode Semiconductor Laser

for Long-Wavelength Optical Fiber Communication, 1978-1983

Citation

Tokyo Institute of Technology researchers first demonstrated a single-mode long-wavelength semiconductor laser with a distributed Bragg reflector in 1978. By 1980, they had demonstrated single-mode operation even under high-speed direct modulation. A phase-shifted distributed feedback laser and a wavelength-tunable laser were both first demonstrated at Tokyo Tech in 1983. These inventions made possible terabit/second wavelength-division multiplexing optical fiber communication systems – the internet's "backbone."

Overview

Professor Yasuharu Suematsu of Tokyo Institute of Technology pioneered the dynamic single-mode semiconductor laser for long-wavelength optical fiber communications. Between 1978 and 1983, his group established the device physics and structures enabling reliable single-mode operation at 1.3–1.5 µm, even under high-speed direct modulation. These breakthroughs transformed optical communications worldwide and remain fundamental to modern photonics.

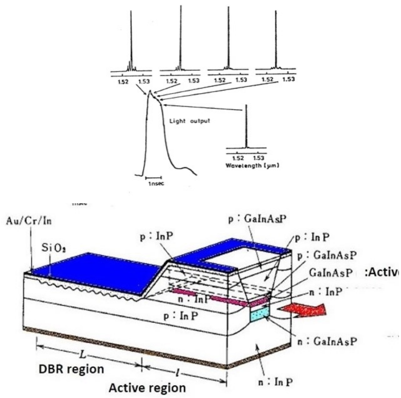
Key Breakthroughs

•1978: First demonstration of a long-wavelength single-mode laser using a distributed Bragg reflector (DBR) resonator.
•1980: Stable single-mode operation maintained under high-speed direct modulation in the 1.3–1.5 µm bands, solving the challenge of mode competition in digital transmission.
•1983: First demonstrations of phase-shifted distributed-feedback (DFB) lasers and electrically tunable single-mode lasers, enabling robust mode control and wavelength agility.

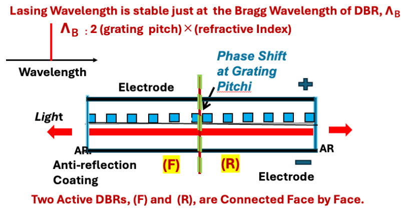
Impact on Optical Communications

These results quickly influenced global developments. Japanese telecom operators NTT and KDD adopted 1.5-µm single-mode lasers for field trials, accelerating deployment of fiber backbones. The Suematsu laboratory also introduced the side-mode suppression ratio (SMSR) as a performance metric, later standardized internationally. Studies of frequency chirp under modulation provided guidance for both IM/DD and coherent systems. By 1987, tunable single-mode lasers were used in trunk lines, and by 1992 in submarine cables, supporting explosive data growth. Electrically and thermally tunable devices later enabled dense wavelength-division multiplexing (WDM), central to broadband and cloud networks.

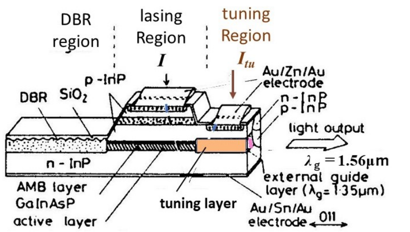
IEEE Milestone Plaque



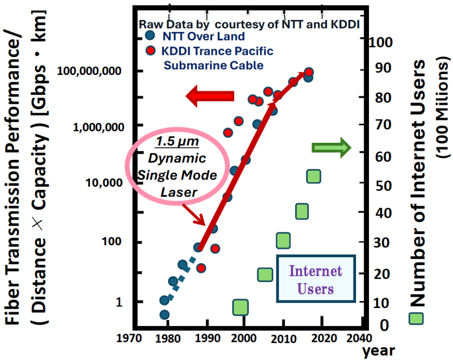
First Achievement of Single-mode Operation of Distributed Bragg Reflector (DBR) Laser at 1550nm under Direct Modulation (1980)



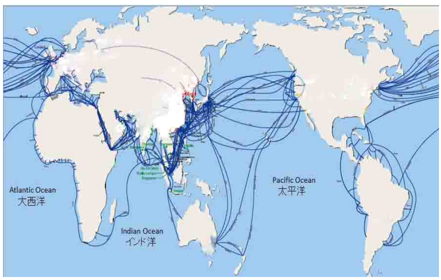
First Achievement of Phase-Shifted Distributed Feedback Laser (1983)



First Achievement of Wavelength Tunable Laser (1983)



Transmission Performance of Optical Fiber and Number of Internet Users (Raw Data by courtesy of NTT and KDDI)



Intercontinental Optical Submarine Cables 2017 (by courtesy of KDDI)

Vertical-Cavity Surface-Emitting Laser, 1977-1992

Citation

The Vertical-Cavity Surface-Emitting Laser (VCSEL), conceived by Kenichi Iga at Tokyo Institute of Technology in 1977, is notable for its single-mode operation, easy monolithic manufacturability, and frequency tunability. Iga's team demonstrated the first current-driven VCSEL in 1979, room temperature continuous operation in 1988, and mechanical continuous-frequency tuning in 1992. VCSELs became widely used in applications such as data communications, laser printing, facial recognition, and LiDAR.

Overview

In 1977, Professor Kenichi Iga proposed the vertical-cavity surface-emitting laser (VCSEL), aiming for single-frequency operation, scalable monolithic fabrication, and frequency tunability. His team achieved the first current-injected VCSEL in 1979, then developed short-cavity devices with low thresholds, circular beams, and wafer-scale array feasibility—laying foundations for communications and consumer applications.

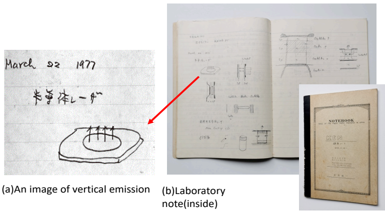
Key Breakthroughs

- 1979: First current-injected VCSEL (GaInAsP/InP) operating under pulsed injection at 77 K.
- Early 1980s: Short-cavity VCSELs with large longitudinal-mode spacing enabled stable single-mode operation.
- 1986: Threshold current reduced below 10 mA in buried-heterostructure AlGaAs/GaAs VCSELs; later records reached tens of microamperes (1995, oxide-confined structures).
- 1988: First room-temperature continuous-wave VCSEL using AlGaAs/GaAs with dielectric mirrors, a breakthrough toward practical devices.
- 1992: Demonstration of mechanical continuous frequency tuning.

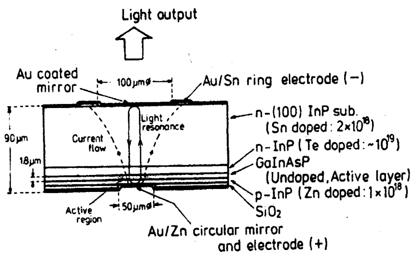
Impact

VCSELs combine low power consumption, wafer-level manufacturability, high coupling efficiency, and the ability to form dense arrays. As the technology matured, these attributes made VCSELs central to short-reach optical links in data centers and local-area networks, while also enabling mass-market products such as laser printers and optical mice. Their compact, low-divergence beams and array compatibility further propelled adoption in 3D sensing, facial recognition, and emerging LiDAR systems. From the original conception in 1977 through key demonstrations in 1979, 1988, and 1992, the VCSEL transformed from a novel cavity concept into a ubiquitous light source underpinning modern information infrastructure and consumer sensing.

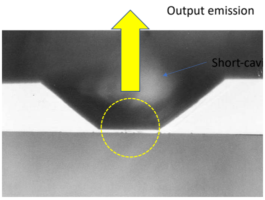
IEEE Milestone Plaque



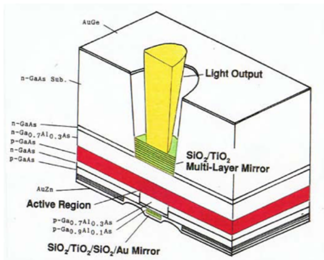
Surface Emitting Laser Conceived (1977)



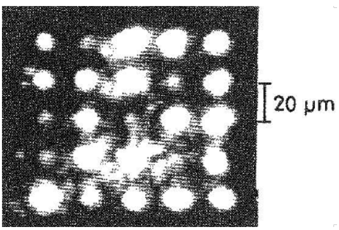
First Laser Oscillation of VCSEL (1979)



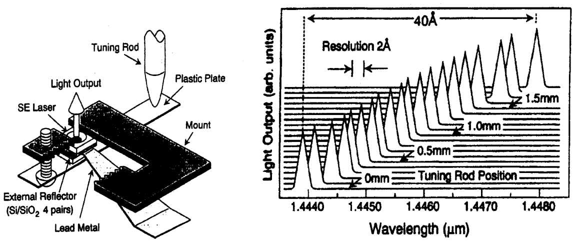
A Short Cavity VCSEL for Single-mode Oscillation (1982)



First Room Temperature Continuous Wave Oscillation (1988)



Two-dimensional VCSEL Array (1988)



First Mechanical Wavelength Tuning (1992)

Institute of SCIENCE TOKYO 東京科学大学

2024年10月、東京医科歯科大学と東京工業大学が統合し「東京科学大学」が誕生

Institute of Science Tokyo established on Oct.1, 2024, following the merger between TMDU and Tokyo Tech

東京工業大学の沿革
History of Tokyo Tech

2022 東京医科歯科大学との統合に向けた基本合意書を締結
Basic agreement signed for integration with National University Corporation Tokyo Medical and Dental University (TMDU).

2018 東京工業大学、指定国立大学法人に指定
Tokyo Tech, selected as a Designated National University Corporation.

2004 国立大学法人 東京工業大学設立
National University Corporation Tokyo Institute of Technology reestablished.

1975 すずかけ台キャンパス建設、総合理工学研究科設置
Interdisciplinary Graduate School of Science and Engineering(Suzukakedai Campus) established.

1949 東京工業大学（新制）
Tokyo Institute of Technology reorganized to comply with national education system reform.

1929 東京工業大学へ昇格
Elevated status to a degree-conferring university, renamed as Tokyo Institute of Technology.

1924 関東大震災により蔵前校舎焼失、大岡山に移転
Tokyo Higher Technical School moved to Ookayama due to Great Kanto Earthquake.

1901 東京高等工業学校と改称
Renamed as Tokyo Higher Technical School.

1890 東京工業学校と改称
Renamed as Tokyo Technical School.

1881 東京職工学校創立
Tokyo Vocational School is founded in Kuramae.

東京医科歯科大学の沿革
History of TMDU

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2020 東京医科歯科大学、指定国立大学法人に指定
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2004 国立大学法人 東京医科歯科大学設立
National University Corporation Tokyo Medical and Dental University was reestablished.

1966 医用器材研究所を設置（駿河台キャンパス）
Institute for Medical and Dental Engineering (Surugadai Campus) established.

1965 教養部を設置（国府台キャンパス）
College of Liberal Arts and Science (Kounodai Campus) established.

1958 医学及び歯学進学課程を設置（国府台キャンパス）
Premedical and Predental Course (Kounodai Campus) established.

1951 東京医科歯科大学（新制）、医学部医学科・歯学部歯学科設置
Tokyo Medical and Dental University reorganized with the establishment of the Faculty of Medicine, the Faculty of Dentistry.

1946 東京医科歯科大学へ昇格
Elevated status to a degree-conferring university, renamed as Tokyo Medical and Dental University.

1944 東京医学歯学専門学校となり医学科を設置
Tokyo Medical and Dental College established, as the School of Medicine is founded.

1930 東京高等歯科医学校を湯島に移転
Tokyo National School of Dentistry moved to Yushima.

1928 東京高等歯科医学校を神田区錦町（一ツ橋地区）に創立
Tokyo National School of Dentistry is founded in Hitotsubashi.

東京高等歯科医学校第一附属病院（湯島）

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東京科学大学理工学系同窓会

Tsurugi-Photonics Foundation