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Join the laser community in celebrating LaserFest– a year-long tribute to 50 years of laser innovation

LASERFEST
CELEBRATING 50 YEARS OF LASER INNOVATION

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ADVANCING THE LASER

50 YEARS AND INTO THE FUTURE

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Due to space limitations this tribute is a somewhat arbitrary selection of the people who have been involved in the success of the laser. Most of those who directly contributed have not been included. SPIE recognizes that this celebration of a transformative invention and its development belongs to a legion of innovators who took Maiman's device and made it so useful and ubiquitous.

“...even if your goal is not achieved, there is still a rich reward for your choice...”

Theodore Harold Maiman

1927 - 2007, United States

Maiman was the inventor of the first laser, a ruby laser which he demonstrated on May 16, 1960. Five decades after this historic event, ruby lasers are still in commercial usage. In 1987 Maiman received the Japan Prize for the invention of the first laser.

“For those of you who are willing to take the risk of blazing new trails, you need to appreciate a reality of life: you will find that the more you deviate from conventional wisdom and the well-beaten paths, the more your consensus of agreement will diminish. Naturally, if you achieve your goal in spite of going against established views, it is especially sweet. But even if your goal is not achieved, there is still a rich reward for your choice. You will experience the thrill and excitement of an adventure. I assure you it will not be boring.”

— Theodore Harold Maiman, Simon Fraser University 2002

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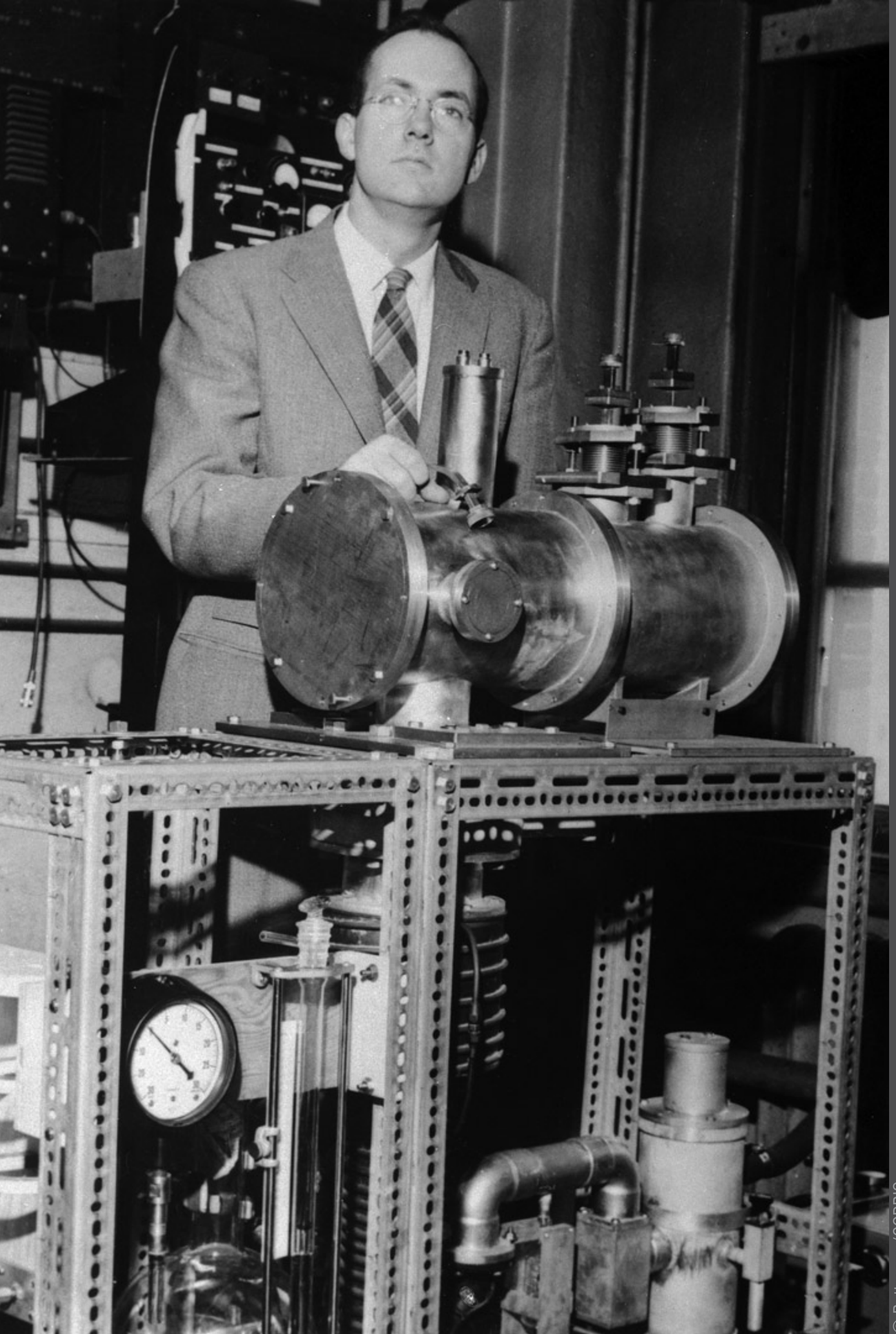

“...solve a puzzle, understand something new, and it’s exhilarating...”

Charles Hard Townes

Born 1915, United States

Townes is known for his work on the theory and application of the maser, on which he got the fundamental patent, and other work in quantum electronics connected with both maser and laser devices. He shared the Nobel Prize in 1964 with Nikolay G. Basov and Alexander M. Prokhorov for “fundamental work in the field of quantum electronics which has led to the construction of oscillators and amplifiers based on the laser-maser principle.”

“I like to try to understand things. You know, that’s a very great human drive, curiosity. What is this world here for? What’s it doing? What makes it work? How does it work? It’s like solving puzzles... In science, you solve a puzzle, understand something new, and it’s exhilarating, and it’s everybody’s property then, which everybody can use. So it’s a permanent contribution.”

— *Charles Townes*

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Credit: AIP Emilio Segre Visual Archives, W. F. Meggers Gallery of Nobel Laureates

“...opened up vast new macrocosmic and microcosmic horizons”

Nicolay Gennadiyevich Basov

1922 - 2001, Russia

Basov shared the 1964 Nobel Prize in Physics with Alexander Prokhorov and Charles Townes for his “fundamental work in the field of quantum electronics which has led to the construction of oscillators and amplifiers based on the laser-maser principle.” He also invented the first excimer laser in 1970.

“Your basic researches in the field of experimental physics, which led to the discovery of the maser and laser, not only laid an inspiring foundation for continuing research, but also opened up vast new macrocosmic and microcosmic horizons.”

— Presentation Speech by S. Friberg, Rector of the Caroline Institute, 1964 Nobel Prize in Physics

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“Many believed that we had gone crazy, that it was impossible”

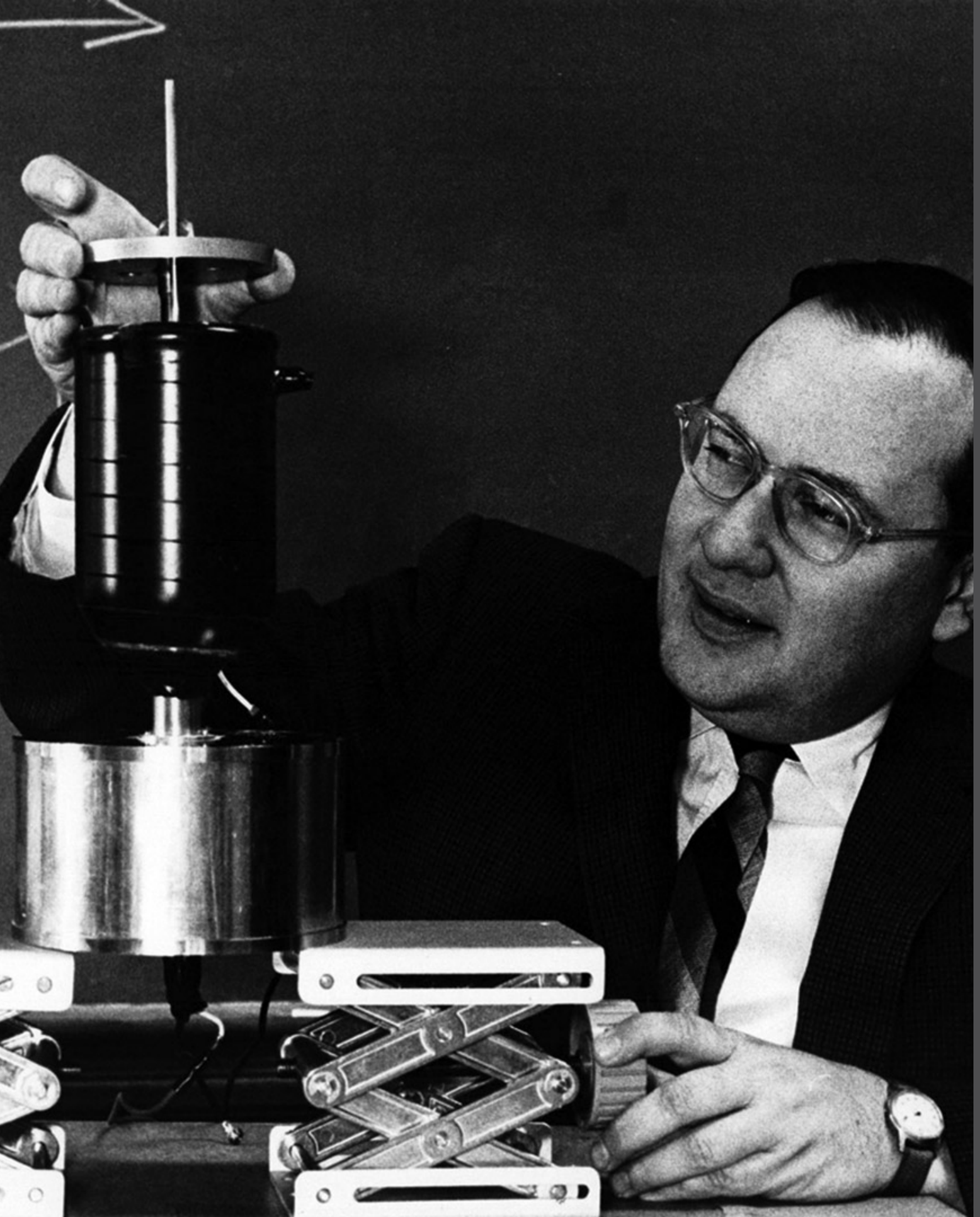
Alexander Mikhaylovich Prokhorov

1916 – 2002, Russia

Prokhorov was a physicist and professor at the Moscow State University. He shared the 1964 Nobel Prize in Physics with Nicolay Basov and Charles Townes for his “fundamental work in the field of quantum electronics which has led to the construction of oscillators and amplifiers based on the laser-maser principle.”

“Many believed that we had gone crazy, that it was impossible, before that no one had said it was possible to create a generator of optical range. Then it became a new, independent science: optics.”

— ***Alexander Mikhaylovich Prokhorov***



> “All you’ve got to do is recognize one thing that’s not known”

Arthur Leonard Schawlow

1921 – 1999, United States

Schawlow is noted for his work on the development and use of lasers. He collaborated with Charles Townes in early work on maser principles. Schawlow received the 1981 Nobel Prize for Physics with Nicolaas Bloembergen for their independent research in laser spectroscopy.

“Well, I guess you say I like to play; that’s true, I like to learn about a subject by getting in and getting my feet wet by trying something, doing some kind of experiment. And one of the things I’d learned by that time, which I’ve since formulated explicitly, is that it’s really not hard to move into a new field and discover something. Because you never have to know everything about the subject. All you’ve got to do is recognize one thing that’s not known. And you just read a few of the latest papers, and you see where they stopped. And you see where the gaps are.”

— Arthur Schawlow, Interviewed by Joan Bromberg at Stanford University, January 19, 1984

“the first time in the history of science that a continuous laser light beam had emanated from a gas laser apparatus”

Ali Mortimer Javan

Born 1926, Iran

Javan received U.S. patent 3,149,290 together with William Bennett for the “Gas Optical Maser.” The gas laser was the first continuous-light laser and the first laser to operate “on the principle of converting electrical energy to a laser light output.”

“And that’s when it happened right on schedule, December 12, 1960. It was the first time in the history of science that a continuous laser light beam had emanated from a gas laser apparatus. I remember looking at my watch. It was 4:20 pm. It had been snowing heavily that day. How do I know it was 4:20 pm? Well, it was a such momentous occasion and I realized the impact that moment would have upon the future of science and technology.”

— ***Ali Javan, Interview with Betty Blair, 1996***

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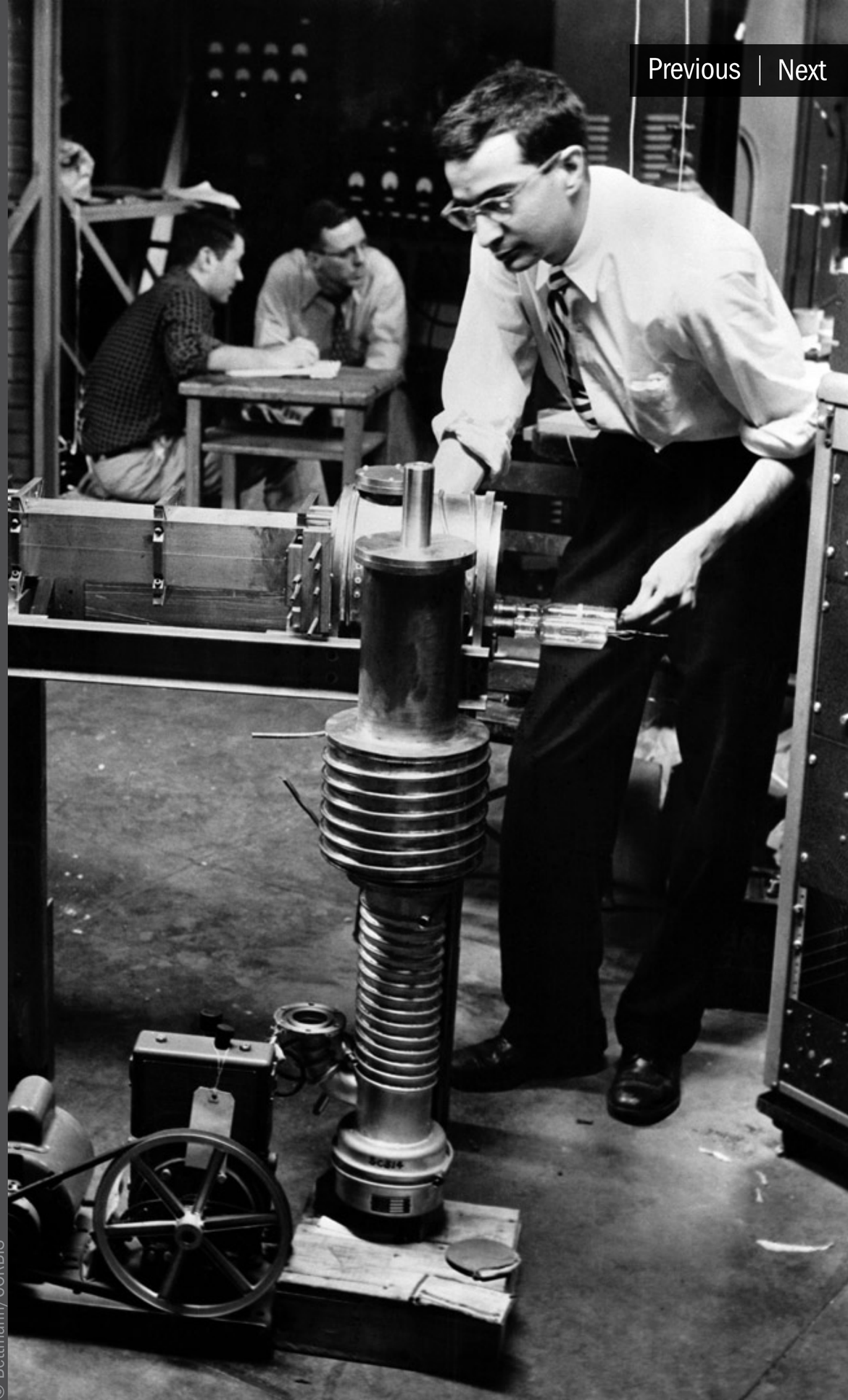

Credit: General Electric Research and Development Center, courtesy AIP Emilio Segre Visual Archives

"You get some ideas, you put them together, the light bulb turns on..."

Robert N. Hall

Born 1919, United States

Hall demonstrated the first semiconductor laser in 1962. He also invented a type of magnetron commonly used in microwave ovens and developed rectifiers for power transmission.

"That was an experience that I really treasure, a classical mode for inventing something. You get some ideas, you put them together, the light bulb turns on and suddenly you see a way of doing it. You go at it as hard as you can, you get some guys working with you that you like to work with. The unexpected thing of this early success made it all the better. There are few such things that happen in a career, but not many."

— ***Robert Hall, Interview with Jeff Hecht***

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“It is so tremendously exciting to make a new laser that I can’t ever imagine not looking forward to coming to work every day, even in slow times.”

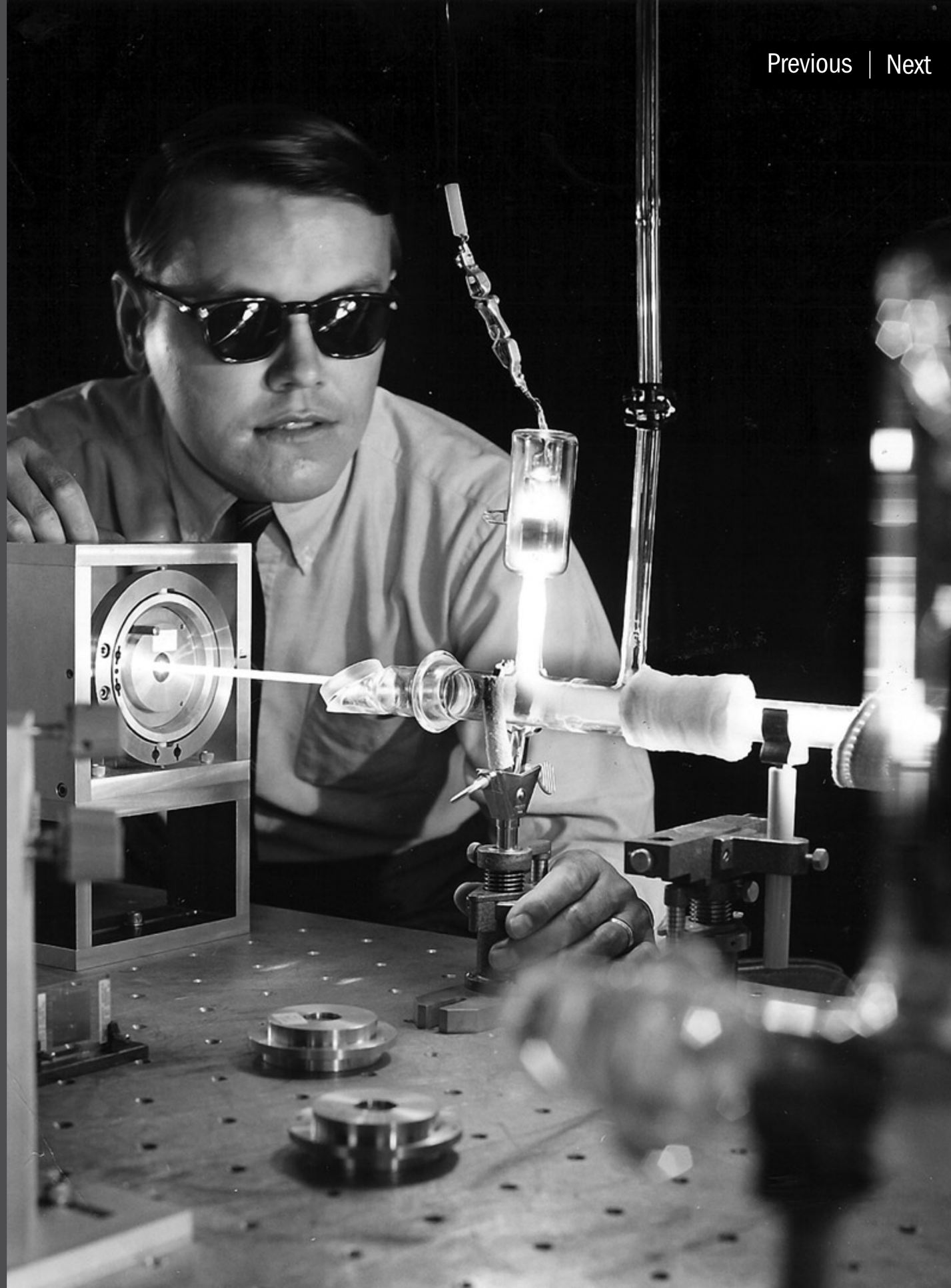
William T. Silfvast

Born 1937, United States

Silfvast is renowned for the number of new lasers he discovered. As a doctoral student he produced laser action for the first time in the vapor of nine elements. He also has done notable work in metal vapors, and demonstrated over 100 recombination lasers and laser action in laser-produced plasmas.

“It is so tremendously exciting to make a new laser that I can’t ever imagine not looking forward to coming to work every day, even in slow times. I’ve probably made more new types of lasers than anybody else, if not in number of wavelengths at least in different species. Many of those new lasers have opened up new areas of research and development, and that’s the kind of excitement that keeps me coming back for more.”

— William T. Silfvast, Interview with Jeff Hecht



“...the business of a glass laser and a fiber were really completely decoupled; they were two separate endeavors”

Elias Snitzer

Born 1925, United States

Snitzer demonstrated the first optical fiber laser in 1961. Snitzer proved the suitability of glass for use as an active laser material. His inventions include both neodymium- and erbium-doped laser glass. Snitzer codeveloped the first fiber optic laser amplifier with laser glass.

“Bloembergen...asked me what the connection was between fibers and this glass laser. And I remember my answer, which surprised some people: ‘Nothing.’ There was no relation in the sense that you didn’t have to make it into a fiber. If you wanted to get a lot of power out of it, you make a big glass laser. On the other hand, if you wanted something that would have special properties that could be provided by fiber, you’d use a fiber. So at that point I would say the business of a glass laser and a fiber were really completely decoupled; they were two separate endeavors.”

— ***Elias Snitzer***

“You have to be encouraged to try things, even if they don’t work”

Gordon Gould

1920 - 2005, United States

Gould was awarded U.S. Patent 4,053,845 in 1977 for the optically pumped laser amplifier. Gould’s laboratory notebook from 1957 contained the first written documentation for making a viable laser. His analysis and suggested applications for the laser appear under the heading “Some rough calculations on the feasibility of a LASER: Light Amplification by Stimulated Emission of Radiation”—the first recorded use of this acronym.

“I think it’s important to be self-critical. You have to weed out all of the aspects of an idea that aren’t going to work, or reject the entire idea in favor of some new idea. You have to be encouraged to try things, even if they don’t work.”

— Gordon Gould, Acceptance speech at the National Inventors Hall of Fame, 1991

“Dialogue and information transfer, from person to person, from people to people, are important, nay essential, for mankind”

Nicolaas Bloembergen

Born 1920, The Netherlands

Bloembergen, a Dutch-born American physicist shared the 1981 Nobel Prize in Physics with Arthur Schawlow and Kai Siegbahn for their work in laser spectroscopy: the study of atomic systems using laser light. Dr. Bloembergen was a pioneer in the field of Nonlinear Optics. He received the 1974 National Medal of Science for Physical Science for “for pioneering applications of magnetic resonance to the study of condensed matter and for subsequent scientific investigations and inventions concerning the interaction of matter with coherent radiation.”

“Lasers contribute to the improvement of communications. Optical communication and information processes will further influence the lives of people in the decades to come. Dialogue and information transfer, from person to person, from people to people, are important, nay essential, for mankind. The fate of all of us on this globe is tied much closer together now than it was a century ago.”

— ***Acceptance Speech by Nicolaas Bloembergen, 1981 Nobel Prize in Physics***

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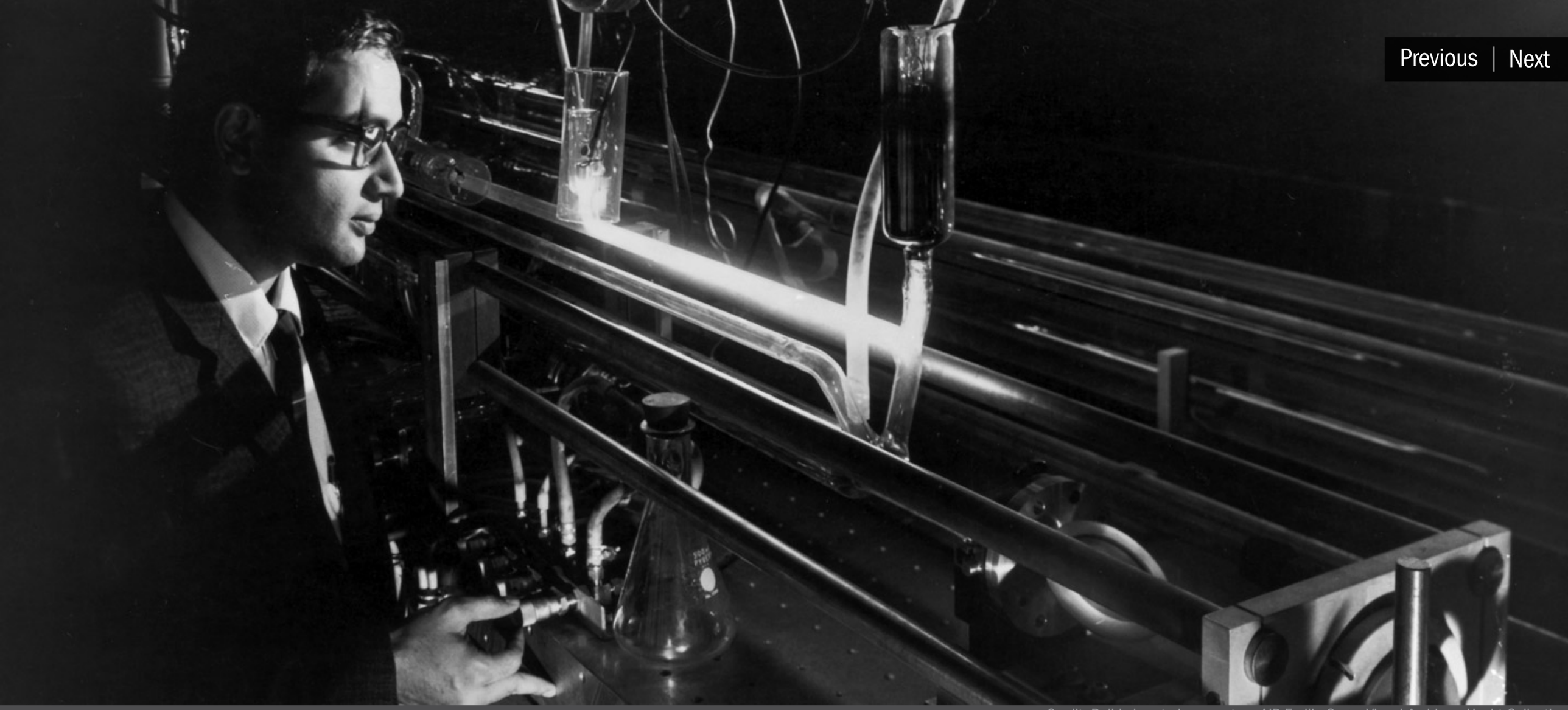

Credit: Bell Laboratories, courtesy AIP Emilio Segre Visual Archives, Hecht Collection

C. Kumar N. Patel

Born 1938, India

Patel developed the carbon dioxide laser in 1963; it is now widely used in industry for cutting and welding, as a laser scalpel in surgery, and in laser skin resurfacing. He currently holds 36 U.S. patents relating to lasers and laser applications.

Kumar Patel won The President's National Medal of Science, "for his fundamental contributions to quantum electronics and invention of the carbon dioxide laser, which have had significant impact on industrial, scientific, medical, and defense applications."

— Citation by President Clinton, 1996 National Medal of Science

"for his fundamental contributions to quantum electronics and invention of the carbon dioxide laser"

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“...science and art, truth and beauty, are eternal values for any civilization”

Dennis Gabor

1900 - 1979, Hungary

Gabor received the Nobel Prize in Physics in 1971 for having “founded the basic ideas of the holographic method.” To acknowledge Gabor’s significant work, SPIE presents the Dennis Gabor Award annually, “in recognition of outstanding accomplishments in diffractive wavefront technologies, especially those which further the development of holography and metrology applications.”

“Yes, science and art, truth and beauty, are eternal values for any civilization which deserves this name, but they can flourish only if they are protected by wise social institutions against the fighting animal in man, which safeguard peace—social and international. My wish is that the talents of the whole next generation should recognize this as their first priority.”

— ***Dennis Gabor***

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“pioneered the field of ultrafast lasers and their applications”

Gérard Mourou

Born 1944, France

Gérard Mourou is a French pioneer in the field of electrical engineering and lasers. Along with Donna Strickland, he co-invented a technique called chirped pulse amplification, or CPA, which was later used to create ultrashort-pulse, very high-intensity (terawatt) laser pulses.

“Professor Mourou pioneered the field of ultrafast lasers and their applications in scientific, engineering and medical disciplines. His research accomplishments include the creation of the ultrahigh-intensity fields, advances in relativistic nonlinear optics, generation of terahertz radiation, development of picosecond high-power switching and picosecond electron diffraction. In the area of applications he pioneered the field of sub-wavelength machining and with medical colleagues the field of femtosecond ophthalmology.”

— Citation, 2005 Willis E. Lamb Award

“for invention and exploitation of the dye laser which laid the groundwork for fundamental studies in physics and chemistry”

Peter Sorokin

Born 1931, United States

Sorokin has made significant contributions to the development of lasers and quantum electronics, including the invention of the dye laser in 1966. He also pioneered ultra-violet lasers with the ability to tune to any wavelength of light. Peter Sorokin is an IBM Fellow Emeritus.

“For milestone advances in laser physics and in the application of lasers to scientific investigations; in particular, for invention and exploitation of the dye laser which laid the groundwork for fundamental studies in physics and chemistry.”

— Citation, 1991 Arthur I. Schawlow Prize in Laser Science

“pioneering the field of stable lasers”

John Lewis Hall

Born 1934, United States

Hall shared the 2005 Nobel Prize in Physics with Theodor Hänsch and Roy J. Glauber for “contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique.” Hall developed techniques that enabled lasers to measure both time and distance with exquisite precision, and this was instrumental in transforming the laser from a laboratory curiosity into a fundamental tool of modern science.

Hall has received many other honors for his pioneering work, including the Optical Society of America’s Max Born Award “for pioneering the field of stable lasers, including their applications in fundamental physics and, most recently, in the stabilization of femtosecond lasers to provide dramatic advances in optical frequency metrology.”

— Citation, Max Born Award

“when the accuracy of measurements is improved, new physics may be discovered and explored”

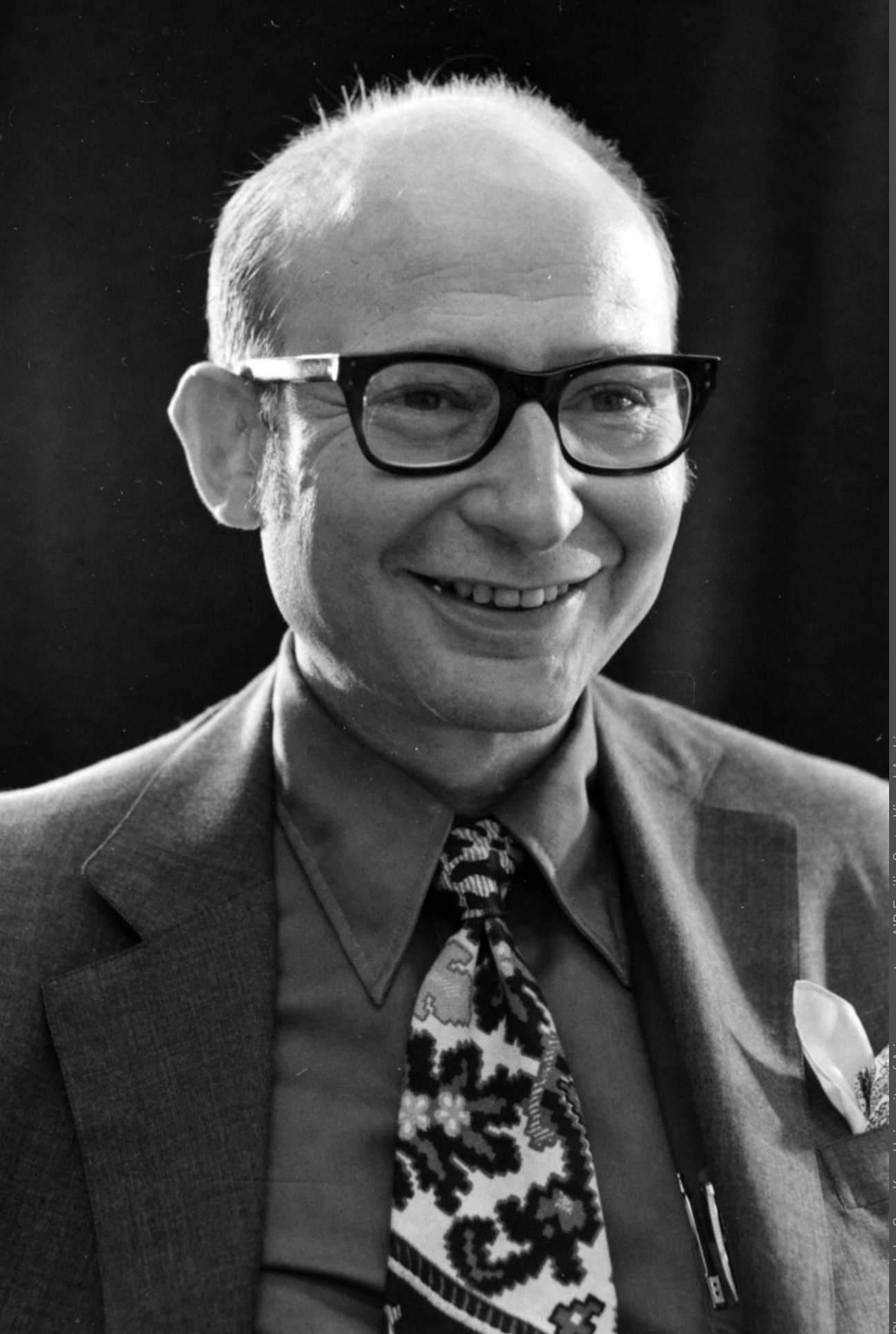
Theodor Wolfgang Hänsch

Born 1941, Germany

Hänsch shared the 2005 Nobel Prize in Physics with John L. Hall and Roy J. Glauber for “contributions to the development of laser-based precision spectroscopy, including the optical frequency comb technique.” The “frequency comb synthesizer” developed by Hänsch made it possible for the first time to measure with extreme precision the number of light oscillations per second.

“The history of physics shows that, when the accuracy of measurements is improved, new physics may be discovered and explored. The work honored today facilitates tests of our basic theories in physics. The character of time and space may be clarified, and the limitations of the laws of physics may be established.

— Presentation Speech by Professor Stig Stenholm, 2005 Nobel Prize in Physics



Photograph by Geo. Kew, University of Arizona, courtesy AIP Emilio Segre Visual Archives

"a nontraditional and 'nonlinear'... approach to the formulation of problems and ways to solve them"

Peter A. Franken

1928 – 1999, United States

Franken, an American physicist, is considered to be the father of non-linear optics. The discovery of non-linear optics occurred in 1961 when Franken focused a high-powered ruby laser onto a quartz crystal generating ultra-violet light mixed with transmitted light. Franken also demonstrated second harmonic generation, a non-linear optical process.

"There are perhaps very few fields of optics and optical applications not contributed to appreciably by Professor Franken—a scientist with a nontraditional and 'nonlinear', dare one say, approach to the formulation of problems and ways to solve them."

A.M. Prokhorov

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“contributions to the invention and demonstration of the quantum cascade laser”

Federico Capasso

Born 1949, Italy

Capasso is known for his work as a prominent applied physicist and as one of the inventors of the quantum cascade laser during his work at Bell Laboratories. He has co-authored over 300 papers, edited four volumes, and holds over 50 U.S. patents.

Federico Capasso has made “seminal contributions to the invention and demonstration of the quantum cascade laser and the elucidation of its physics, which bridges quantum electronics, solid-state physics, and materials science.”

— Citation, 2004 Arthur L. Schawlow Award

“my dream is to see lasers—like computers—become a tool of choice in mass production”

Valentin Gapontsev

Born 1939, Russia

Gapontsev is recognized as “the father of the fiber-laser industry as it is known today, who has pioneered the field in five decades of academic work and as the founder and CEO of a global technology company (IPG) that continues to transform the laser industry.” Citation, Arthur L. Schawlow Award Presented to Valentin Gapontsev in 2009

“Looking forward, my dream is to see lasers—like computers—become a tool of choice in mass production, rather than being viewed as a last resort in many applications. I intend for IPG Photonics to play a pivotal role in realizing this dream, and being sure to maintain our independence along the way.”

— ***Valentin Gapontsev***

Courtesy of Worcester Polytechnic Institute

“Without optical fibers and amplifiers it is hard to imagine the Internet we know today.”

David N. Payne

Born 1944, England

Payne has been instrumental in the advancement of optical fiber communications. He led the team at Southhampton that first demonstrated the erbium-doped fiber amplifier. Payne’s work in fiber fabrication in the 1970s resulted in many of the special fibers used today.

“I was incredibly fortunate to be offered the opportunity to work as one of the first in optical telecommunications. It created the high speed connected world and its outstanding success has been one of man’s greatest achievements. Without optical fibers and amplifiers it is hard to imagine the Internet we know today.”

— David Payne

“without intense theoretical activity, a high-powered laser could never be realized”

Adolf Giesen

Born 1946, Germany

Giesen demonstrated the disk laser in 1993. The thin-disk laser is a diode-pumped solid-state laser that produces high output power with both high efficiency and excellent beam quality, overcoming the thermal limitations of conventional laser rods. Since the first demonstration, the continuous-wave output power extracted from a single disk has increased to more than 5 kW.

“I’m not the typical theoretician, but rather an experimental physicist with a heavily theoretical background and an enormous practical interest. But without intense theoretical activity, a high-powered laser could never be realized.”

— ***Adolf Giesen***

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“fundamentally changed the way scientists view chemical reactions”

Ahmed Zewail

Born 1946, Egypt

Zewail is the winner of the 1999 Nobel Prize in Chemistry for his work on femtochemistry. He also has been nominated and will participate in President Barack Obama’s Presidential Council of Advisors on Science and Technology (PCAST).

“Femtochemistry has radically changed the way we look at chemical reactions. A hundred years of mist surrounding the transition state has cleared. Professor Zewail, I have tried to explain how your pioneering work has fundamentally changed the way scientists view chemical reactions. From being restricted to describe them only in terms of a metaphor, the transition state, we can now study the actual movements of atoms in molecules. We can speak of them in time and space in the same way that we imagine them. They are no longer invisible.”

— Presentation Speech by Professor Bengt Nordén of the Royal Swedish Academy of Sciences, 1999 Nobel Prize in Chemistry

“Each time the electron is deflected it emits a burst of radiation”

John M.J. Madey

Born 1943, United States

Madey invented and developed the FEL in 1971, a relativistic electron tube that made use of the open optical resonator. An important step in FEL development came in 1976 when Madey and his co-workers at Stanford University measured gain from an FEL configured as an amplifier at 10-μm wavelength.

“FELs exemplify the subtlety of the fundamental processes by which electrons can transfer their energy to the electromagnetic field. The concept first arose in the context of a discussion by a group of CalTech undergraduates in 1964 as to whether it might be possible to enhance the transition rate for bremmsstrahlung through stimulated emission, and has remained a subject of vital interest as we consider the means by which these devices can be adapted to produce beams of unprecedented coherence and power. We have surely learned as much through these developments as we have achieved through the advances in the technologies to which we have contributred.”

— ***John Madey***

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“a splendid example of perseverance and dedicated research work”

Shuji Nakamura

Born 1954, Japan

Nakamura invented the first high brightness GaN LED which could be mass produced. The brilliant blue light of the LED, when partially converted to yellow by a phosphor coating, is the key to white LED lighting. His technique led to the commercial viability of blue and violet semiconductor lasers.

“Shuji Nakamura is a splendid example of perseverance and dedicated research work, and of making a major breakthrough. He has worked with great determination for decades, and even severe setbacks have not prevented him from achieving something that other workers in the field regarded as almost impossible: using a reactor system of his own design to develop a solid material, in this case gallium nitride, into a powerful light source producing blue, green and white light, and also creating a blue laser.”

— *Citation, 2006 Millennium Prize*

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"better science education for all, not just science majors, is vital for continued scientific progress of our nation"

Eric Mazur

Born 1954, The Netherlands

Mazur is known for his work in experimental ultrafast optics and condensed matter physics and as a national leader in science education.

"Dr. Mazur has devoted his life to science and is a recognized scientist and researcher, who leads a world-recognized optical physics research program. His strong interests in education, science policy, outreach and public perception of science leads him to devote considerable time to education research and identifying verifiable ways to improve science education. He believes that better science education for all, not just science majors, is vital for continued scientific progress of our nation."

— ***Citation, 2008 Robert A. Millikan Award from the American Association of Physics Teachers***

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"Whenever you push physics into an area that it has never been before there are always exciting discoveries"

Peter Moulton

1946, United States

Moulton first demonstrated the Ti: Sapphire laser in 1982 at MIT Lincoln Laboratory. His technical work began in the field of bulk solid state lasers, and in recent years has extended to include nonlinear optics and fiber lasers.

" I have been amazed as to how things have developed to the point where you can freeze molecules in their state and also with lasers generate electric fields that are higher than you can get in accelerators so that allows you to go into a field of high energy physics that you might not of thought a laser would do....Whenever you push physics into an area that it has never been before there are always exciting discoveries, you can't predict what they are going to be, but just probing into a new area is bound to generate something exciting."

— Peter Moulton, SPIE Interview January 2010

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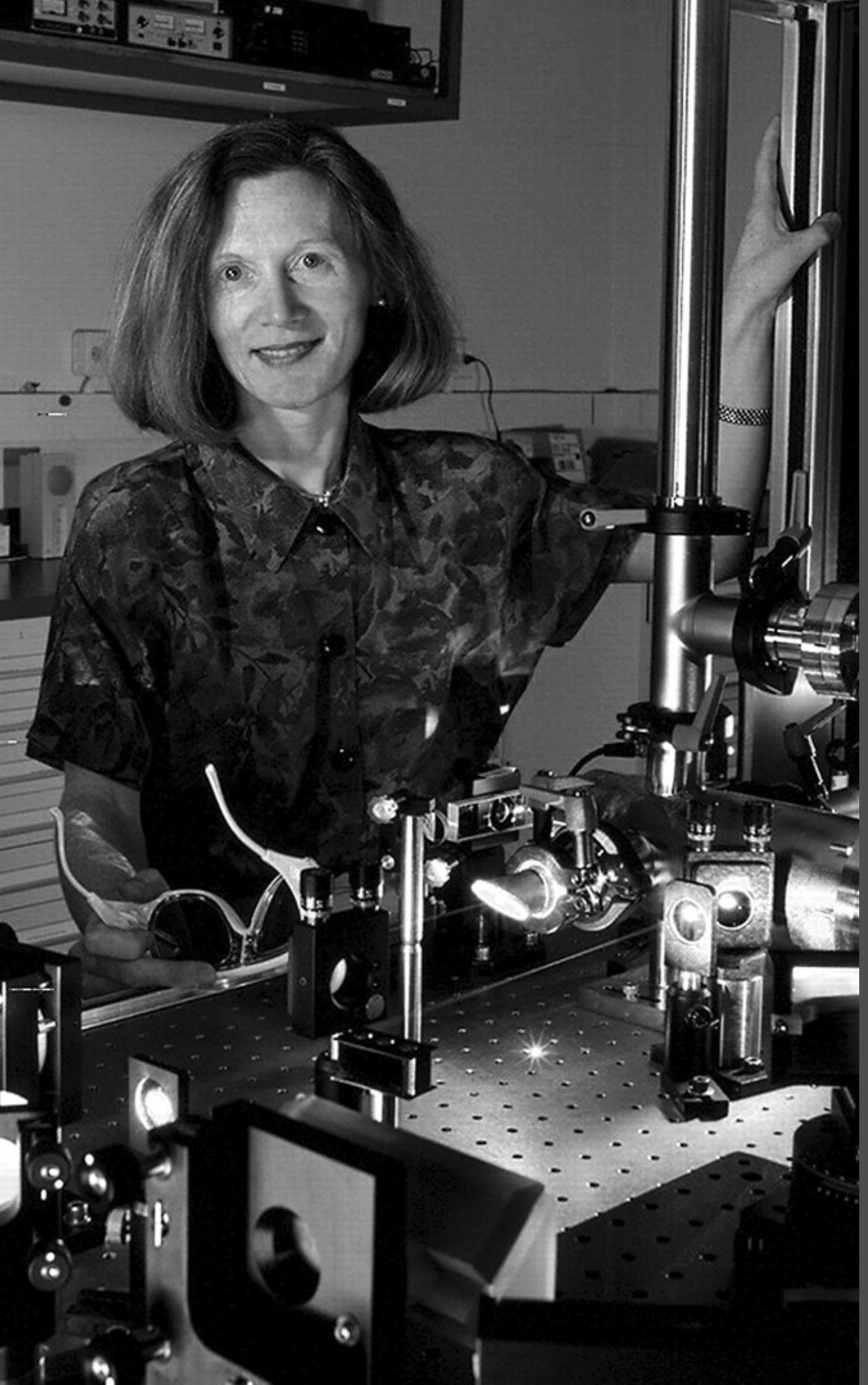


“the thrill of discovery; the opportunity to collaborate”

Margaret Murnane

Born 1959, Ireland

Murnane is recognized as a laser pioneer for her work in ultra-fast laser science and for the development of ultra-fast optical and coherent soft X-ray sources. In 2000, Murnane won the prestigious MacArthur Fellowship. Her work has had valuable applications in optical technology, faster computer chips, and biological and medical imaging.

What I find exciting is “the thrill of discovery; the opportunity to collaborate with scientists from all over the world with different expertise from mine, in many areas of science and engineering; the limitless energy of the students; and the ability to help the next generation of scientists and engineers succeed.”

— Margaret Murnane, SPIE Interview

> “I am delighted to have had the opportunity to make some contributions that have proved to be significant and useful”

Wilson Sibbett

Born 1948, N. Ireland

Sibbett FRS CBE is renowned for his innovative work on ultrashort-pulse lasers and related diagnostic techniques, along with the development of the self-mode-locked laser, demonstrating the first Kerr-lens mode-locking technique in a titanium-sapphire laser. He was made a Fellow of the Royal Society in 1997 and awarded the Rumford Medal in 2000.

“Having undertaken research into ultrashort-pulse lasers for approximately four decades, I am delighted to have had the opportunity to make some contributions that have proved to be significant and useful. It gives me particular satisfaction that these related laser advances have helped to lead to so many impressive and still-evolving applications in both ultrafast science and technology.”

— ***Wilson Sibbett***

“His vision, tenacity and boundless energy...inspired a whole generation of laser scientists”

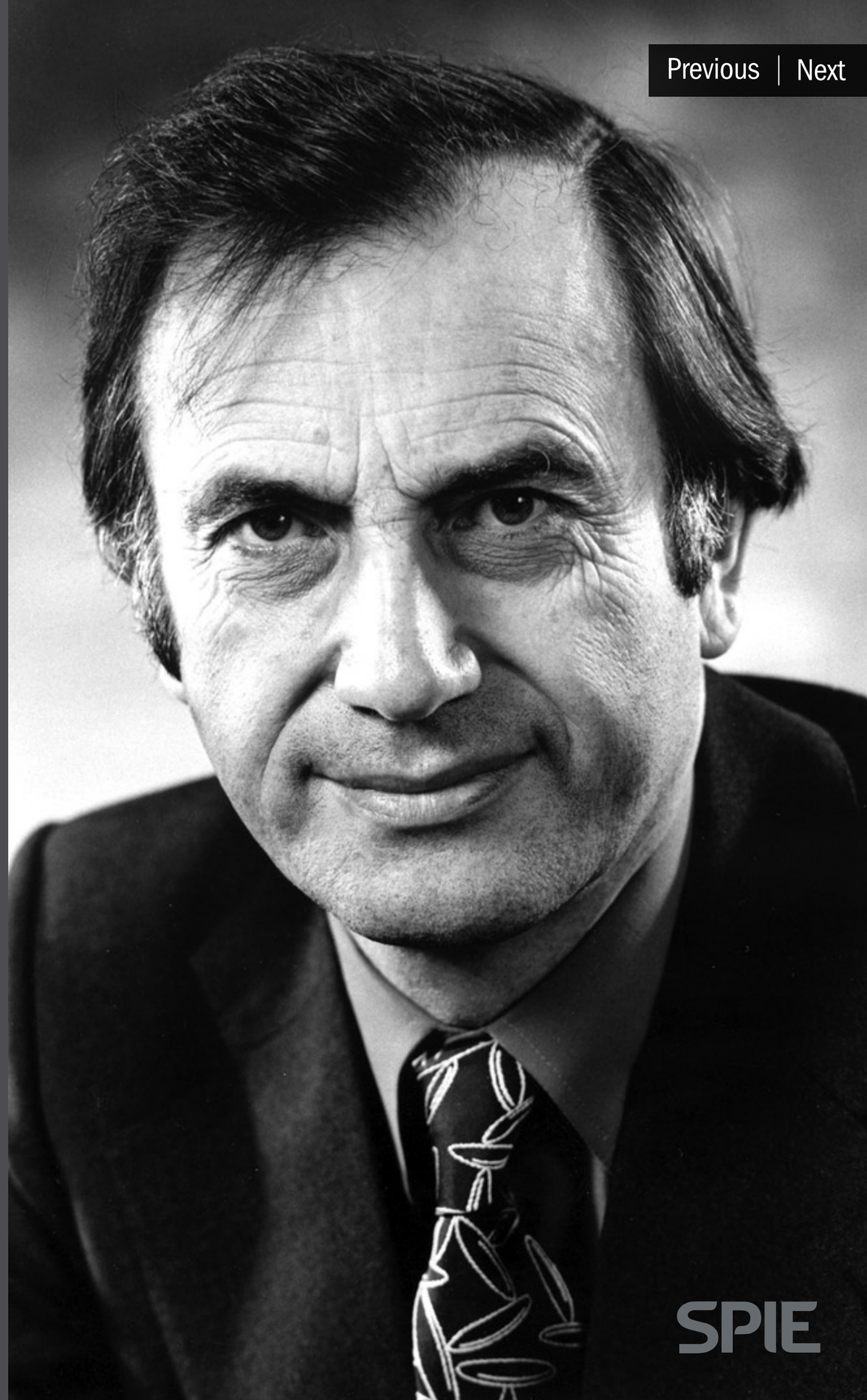
Daniel Joseph Bradley

1928-2010, Ireland

Bradley is known for his world-leading work in ultrafast pulsed lasers and tunable lasers. He also developed and patented picosecond streak cameras. During his career he received many honors, including a Cunningham Medal from the Royal Irish Academy in 2001 for his outstanding contribution to scholarship and to the objectives of the Academy, and a Royal Society’s Royal Medal in 1983.

“Dan Bradley created the first major effort in laser development and their applications in the UK. His vision, tenacity and boundless energy in those early days of lasers inspired a whole generation of laser scientists.”

— ***Martin Richardson, Director of the Townes Laser Center at the College of Optics & Photonics, University of Central Florida***



“...the enthusiasm I see in the lab today is something I find most satisfying to behold.”

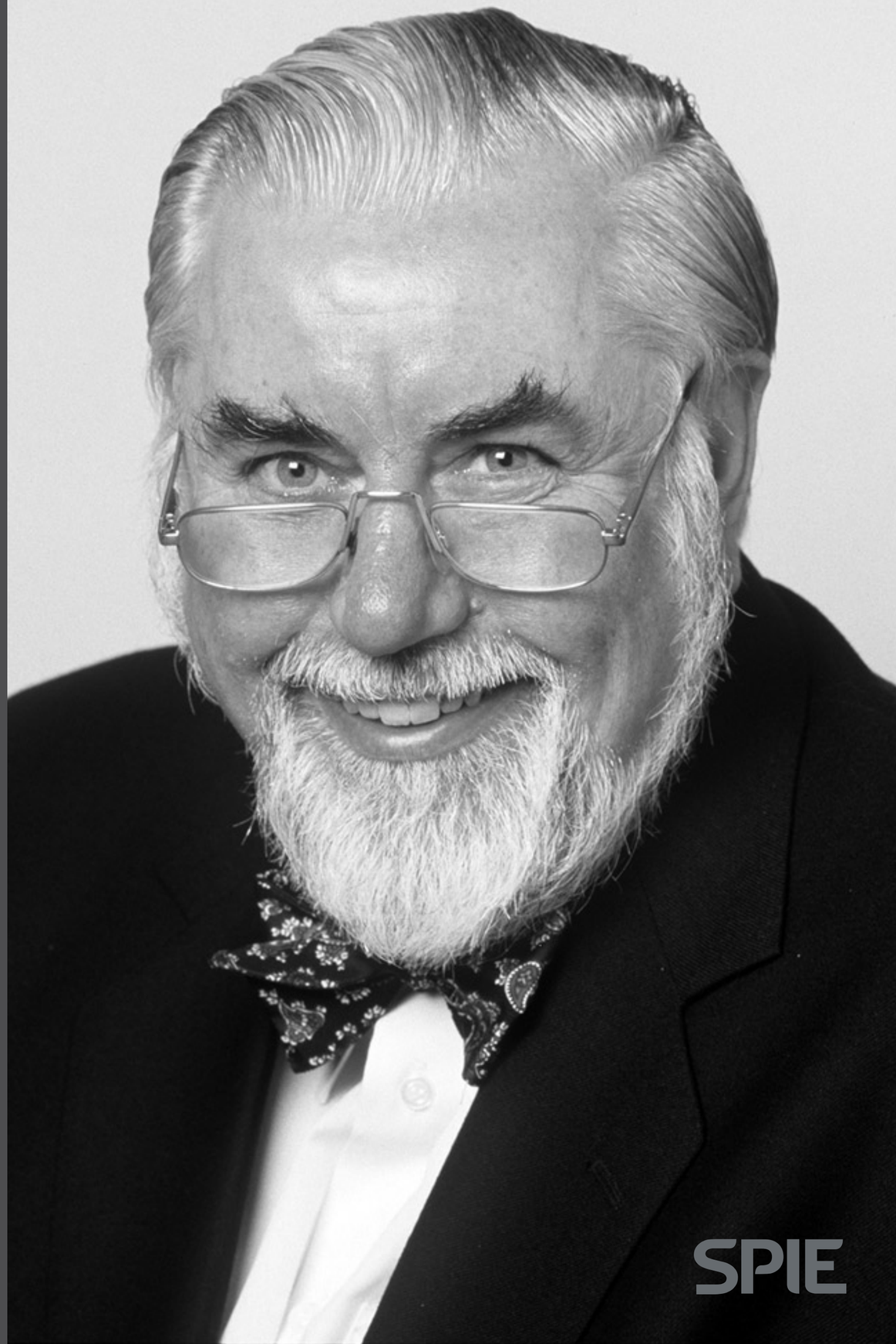
Colin Edward Webb

Born 1937, England

Webb is known for his pioneering work in gas lasers. As a gas laser innovator he discovered 30 new laser transitions and assessed their suitability for subsequent exploitation. He was made a Member of the Order of the British Empire in 2000. He was awarded the Duddell Medal and Prize in 1985 by the Institute of Physics and delivered the Paterson Lecture of the Royal Society in 1999.

“Fifty years ago, at the outset of my research career, I could never have imagined how the field of laser physics would grow and the applications of lasers would expand to cover totally unexpected areas of science and technology. The palpable excitement of today’s young scientists, the wealth of new research problems and the enthusiasm I see in the lab today is something I find most satisfying to behold. All this in the field of optics, which many senior colleagues warned me was dead and devoid of interest before I started back then in October 1960.”

— ***Colin Webb, June 2010***



“seeing the connection between lasers and lithography, something that had long been deemed not to be possible”

Kanti Jain

Born 1948, India

Kanti Jain, who pioneered the field of excimer laser lithography, has been making his mark on the industry for more than three decades. He was elected to the US National Academy of Engineering in 2009, “for contributions to the development of high-resolution, deep-ultraviolet excimer lithography for microelectronic fabrication.” Dr. Kanti Jain is Professor of Electrical & Computer Engineering at the Univ. of Illinois and President and Founder of Anvik Corporation.

> *“ A major factor that, I believe, plays a key role in breakthrough innovations is the opportunity, and the ability, to straddle across seemingly disconnected fields. This was precisely the spark—my lucky ‘Eureka’ moment—that led to the invention of excimer laser lithography—seeing the connection between lasers and lithography, something that had long been deemed not to be possible.”*
>
> — ***Kanti Jain***

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