LIA TODAY


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4100
50 YEARS
LASER FOCUS
INCLUDING ELECTRO-OPTICS MAGAZINE

LASER INSTITUTE OF AMERICA NEWSLETTER

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LASER INSTITUTE OF AMERICA NEWSLETTER

Published Six Times Per Year by the LIA

VOL. XXVI - No. 5 October 2018

PRESIDENT'S MESSAGE

As we get closer to the end of the calendar year, and my Presidency, I can report on some positive developments within LIA. The first is that LIA, under the leadership of Nat Quick, has made tremendous progress in turning the "fortunes" of LIA around. The "turnaround" year, as is commonly referred to by the Executive team, has seen some hard decisions made at its beginning. These have been difficult as they ultimately involved people, but were necessary for the long term growth and prosperity of LIA. Our expenses this year have been reduced significantly and our income from different sources is rising. As mentioned in my previous message the budget for FY2019 has been completely rebuilt for each business unit and now better allows the Executive office to track revenues and expenses and provide alerts when modifications are required. We are reviewing staffing to ensure we have resources in the correct areas to support various growing activities and initiatives. I shall report more on this later in the year following the Executive and Board meetings at ICALEO.

The second relates to ICALEO, our flagship conference. It is almost upon us and I urge you to register if not already done so as it is shaping to be one of our best ICALEOs for the past few years. In this context I am happy to report that we have arrested both the decline in registrations and total income compared to the four previous ICALEOs. If the current trend in registrations continues it will be the highest registration count in the last four years. This combined with the very exciting ICALEO program put together by Christoph Leyens from Fraunhofer IWS Dresden, the General Chair of ICALEO and his co-chairs, Klaus Kleine (Coherent), Friedhelm Dorsch (Trumpf), Eric Motay (Amplitute Systems), Robert Braunschwig (Lasea), Yongfeng Lu (Nebraska-Lincoln), Klaus Loeffler (Trumpf) and Bo Gu (Bos Photonics) and the planned 50th year celebrations shall make this ICALEO one of the most enjoyable and memorable in a long time.

I look forward to ICALEO and to meeting many of you.

Sincerely,

M. Brandt

Milan Brandt
President, LIA

EXEC. DIRECTOR'S MESSAGE

Recently I came across a copy of LIA's old newsletter, Laser Topics, from 1987. This was the year I became a member of LIA to keep abreast of laser materials processing. It reminded me that the 1987 corporate member directory section provided me with collaborators and customers for the electronic materials processing technology we were developing at that time.

For the past 50 years, LIA and its network has provided an environment that nurtured innovation and the bridge to commercialization. This has provided value for all members. Our brand is the recognized leader in laser safety education, and much of our network falls in the niche between applications development and production. However, our membership base must not be limited to just the laser/ photonic vendor tier, but must aggressively expand to include laser/photonics integrators and particularly laser/ photonic users.

Moving into the next 50 years of LIA, we must grow the environment that nurtures innovation in laser/ photonics technologies. We will approach opportunities as entrepreneurs.

To truly know where we are going, we must know where we come from. In this issue of LIA TODAY, we enjoy a look at LIA's past through the eyes of David Belforte and track back through history with pages from our earliest newsletters. Then, articles shift from recollections about our laser pioneers and early laser applications to laser product safety engineering considerations for moving lasers, and innovations in laser treatments of cancer. With our values firmly grounded in our rich history, and with our eyes set on the future, I'm looking forward to LIA launching its next 50 years with the celebration at ICALEO 2018. In closing, it is with great admiration that LIA congratulates Arthur Askin, Gérard Mourou and Donna Strickland who were awarded the 2018 Nobel Prize in Physics for "ground breaking inventions in the field of laser physics".

Sincerely,

Nat

Nat Quick
Executive Director, LIA

TIMELINE 1960 - 2018

Five Decades of Supporting Laser Innovation

LIA 50 YEARS 1968–2018

1960 - Theodore Maiman demonstrates the laser using a ruby crystal in his laboratory.

1960

1964 - Charles H. Townes shares Nobel Prize in Physics for the invention of the laser; initiates program of radio and infrared astronomy at University of California, Berkeley.

1964

1968 - Laser Industry Association, later becoming the Laser Institute of America is incorporated. The original logo was supposed to be an arrow, but was fondly known as the “little man logo”.

1968

ASC Z136 Safe Use of Lasers Accredited Standards Committee

1973 - The first Z136 Standard is introduced.

1973

1975 - LIA promotes a contest to create the new LIA logo, offering a cash prize of $25.

1975

1982 - Co-inventor of the laser, Arthur L. Schawlow is presented the first Schawlow Award at the first ICALEO®.

1982

Journal of Laser Applications

1988 - The Journal of Laser Applications publishes Volume 1, Issue 1 in October 1988.

1988

ILSC INTERNATIONAL LASER SAFETY CONFERENCE

1997 - The first International Laser Safety Conference (ILSC) is sponsored by LIA.

1997

OSHA alliance An OSHA Cooperative Program

2005 - LIA becomes an OSHA Alliance.

2005

LAM LASER ADDITIVE MANUFACTURING CONFERENCE

2008 - LIA offers its first ever Laser Additive Manufacturing Workshop (LAM), to help industry specialists, executives, researchers, and users learn how cladding and rapid manufacturing can be applied effectively and affordably to today’s manufacturing challenges.

2008

2018 - Celebrating 50 years of LIA and navigating its venture into the 21st century.

2018

Celebrating LIA's 50th Anniversary

A Lifetime with the LIA

Originally printed in January / February 2018 LIA TODAY

BY DAVID BELFORTE

David Belforte in his early years, around 1980.

I joined LIA in 1971 at the urging of members Jim Smith (IBM), Dave Edmunds (Xerox) and Dave Sliney (U.S. Army Center for Health Promotion and Preventive Medicine). At the time, I was part of an intrapreneurship spin-off from the Research Division of American Optical Corporation (AO) with a charter to test a then-new concept, a commercial venture called Laser Products using the company's Nd:Glass laser technology. AO scientist Dr. Mason Cox, then president of LIA, introduced me to Smith, Edmunds and Sliney because of my interest in advancing the idea of laser welding with the AO technology.

LIA was incorporated in 1968. By 1971, LIA was undergoing a mission change as many of the founding members, mostly laser scientists and physicists like Dr. Arthur Schawlow and Dr. Theodore H. Maiman, were being superseded by laser engineers and managers from budding laser product companies. Laser eye safety was the connecting tissue as many of the members served in that function for the organizations for which they worked, such as Messer's Smith, Edmunds and Sliney along with Jim Rockwell (Rockwell Associates) and Sid Charschan (Western Electric).

In the early days, most LIA members were associated with other professional societies, many holding offices or chairing various committees or conferences. I, for example, belonged to the American Welding Society (AWS), American Society for Metals (now ASM International) and Society of Manufacturing Engineers (now SME), all of which were interested in this new technology—laser processing—as was I. LIA members had other society time commitments, however, being part of a society involved with the dynamic and seemingly limitless laser technology, with a mission to advance it, was too compelling. Plus LIA had a very compatible core of individuals sharing a common interest, who became members united with common interests in laser safety and materials processing. With them, the organization gathered the strength to consider expansion.

In 1972, incoming President Jim Smith asked me to become a member of the Board of Directors, a position I was to hold for many years. My first duty was to attend a board meeting held in conjunction with an Optical Society of America (OSA) annual conference and trade show in Washington, DC. When Smith called the meeting to order, it quickly became evident that only seven of us—three officers and four directors—would make up the quorum. Regardless, it was a good session with a lunch in between a full agenda of work. As we finished and prepared to leave, Jim sheepishly requested that we all chip in to cover the lunch tab.

So this was my introduction to the "new LIA"—it was essentially broke, had no staff, and had no headquarters. As I flew back home, I contemplated my other activities in the well-funded AWS, ASM and SME compared to the understaffed (everyone was a volunteer) and underfunded LIA. Deciding that great potential existed for building the organization and working with a great group of laser enthusiasts, many of whom went on to be life-long friends, was a challenge worth undertaking.

That same year, Jim Smith, Dave Edmunds, Jim Rockwell and I met with the publisher of a leading technology publication whose wisdom and support we sought to help us grow LIA and make it a factor in laser technology advances. We left this meeting depressed that he had very little regard for the organization and its future.

Some of his negative thoughts, however, became part of the goals we set for the "new" LIA—grow a membership by providing them with the services other societies did not, establish a professional management team, and position LIA as the driving force in specific laser technology sectors. Many years after, that publisher told me he had given us little chance of success but admitted he had misjudged our determination and energy. Shortly after that initial meeting, on April 26, 1973, LIA published the first Z136 standard—the American National Standard for Safe Use of Lasers (ANSI Z136.1).

Five years later, at the LIA's 1978 annual meeting in Anaheim, California, I, as president, presided over the first Honored Speaker Award to Dr. Leon Goldman (University of Cincinnati), which eventually became the Arthur Schawlow Award. This essentially

Past Presidents of the LIA in attendance, from left to right: Dave Whitehouse, Bob Goldstein, Dave Belforte, Milton Chang, Bill Tiffany, Jim Rockwell, and Dave Edmunds in 1986.

initiated what was to become the published cosponsored history of *The Laser in America*. In 1981, I created and presided over the first (and only) Joint U.S./Japan International Conference on Laser Material Processing, which President David Whitehouse, in 1982, morphed into LIA's highly regarded International Congress on Applications of Lasers & Electro-Optics (ICALEO®).

In 1985, Accuratus Ceramic Corporation became LIA's first corporate member, leading to the expansion of LIA's membership services. LIA also added to its publishing repertoire in 1988, when the first LIA Today newsletter debuted.

LIA officers confir at headquarters building, 4100 Executive Park Drive, Cincinnati, Ohio. President R. James Rockwell, Jr. (at right) confirs with James Smith (center) Past-president and current chairman of the LIA Educational Committee and David Edmunds, President-elect, prior to LIA Board of Directors meeting held in Cincinnati, Ohio concurrent with the short courses co-sponsored by LIA in early August 1974.

In 1995, LIA honored me with the Schawlow Award for my contributions to the advancement of industrial laser material processing, which primarily were a consequence of my years in the organization.

Since then, LIA has introduced three more successful conferences: The International Laser Safety Conference (ILSC®) in 1997, the Laser Additive Manufacturing (LAM®) conference in 2008 and the Lasers in Manufacturing Event® (LME®) in 2011. Over the years, LIA has had almost 5,000 individual members and more than 500 corporate members. Of those, around 2,000 individual and 160 corporate members are active today.

Looking back on the 50 years of LIA from its current preeminence as a global leader in laser safety and advanced laser material processing, with a well-staffed headquarters in Orlando, Florida, fiscally sound and professionally managed, I recall all the opportunities LIA brought me, the wonderful people I met and worked with, and best of all, I never picked up the tab again. ■

David Belforte is Editor-in-Chief of Industrial Laser Solutions.

The Laser Safety Movement:

40 Years of Leading, Educating, and Protecting

Originally printed in March / April 2008 LIA TODAY

BY HEATHER TEAGUE, WITH CONTRIBUTION FROM DR. DAVID SLINEY
WITH 2018 UPDATE BY GUS ANIBARRO

THE EARLY YEARS

When Theodore Maiman invented the ruby laser in 1960—considered to be the first successful optical laser—it raised a simple, yet highly complicated question: Are lasers safe? Indeed, in the early 1960s some engineers characterized the output energy of the first lasers in terms of "Gillettes" – by having the power to burn through razor blades.

Within one year after Maiman's development, two papers were published in Science magazine that pointed out why a laser is so dangerous (especially to the retina). The potential for damage to the eye was recognized as early as 1961 [1-2].

The 1960s can be described as the early beginnings of the laser safety movement, including an extensive research phase. Safety-oriented research efforts were conducted to quantify the actual risk for eye injury [1]. The first study of significance was by Dr. Milton Zaret [2]. Also occurring during this period, TRG, American Optical, Perkin-Elmer-SpectraPhysics, and other companies began making and selling commercial lasers.

As a result of working around lasers without safety precautions, a number of accidents occurred during this time and the first laser safety guidelines became available [3-4]. And, the industry became increasingly concerned about the laser's potential to cause eye injuries. Large companies such as RCA and American Optical, who stood to profit greatly from the commercial applications of the laser, became worried that the government would prohibit the use of lasers altogether. It was time to take action to protect a highly promising technology. The Laser Institute of America (LIA) owes this concern as one of the major reasons for its formation in 1968.

INDUSTRY JOINS FORCES WITH ANSI

The industry quickly realized the solution to the safety problem was the development of standards, along with better training and education about the safe use of lasers. A collaborative effort was made to organize a laser safety committee in conjunction with the American National Standards Institute (ANSI) with George Wilkening as Chair and the Telephone Group as the initial Secretariat.

From 1968-1972, there was a major push for developing laser safety standards. The question that was debated frequently and extensively was to what level of exposure is considered to be safe [3]. Many late-night meetings were held at ANSI's office in New York to determine the standards that would become the first edition of ANSI Z136.1, Safe Use of Lasers in 1973. Later, the LIA became the secretariat and publisher of the ANSI Z136 series—the foundation of laser safety programs nationwide.

LASER CLASSIFICATION PREVENTS EXCESSIVE RESTRICTIONS

In comparison to other workplace safety hazards, the laser is unique because of its potential risk of injury to the eye, even at far distances. It is also different from other intense light sources due to its very high radiance. Maximum Permissible Exposure (MPE) limits, introduced in the mid-1960s, have now become standardized and essentially the same worldwide [3, 5-6].

All lasers are not created equal. In fact, there's a low probability of sustaining an eye injury in most applications—certainly for small collimated beams, where the beam must be aligned to the pupil for a retinal injury to occur. Therefore, a laser classification system was developed to classify lasers by their hazard potential, which was based upon their optical emission. For each classification, a standard set of control measures apply [5].

Basically, Class 1 denotes lasers or laser systems that do not pose a hazard. Classes 2 through 4 pose an increasing hazard to the eye and skin. [5]

The main advantage of this Class 1-4 rating system is that it prevents excessive restrictions from being placed on the use of many types of lasers. Manufacturers have been required by Federal regulations to classify their lasers since 1976. [5]

As the use of medium and high-powered lasers increased, it became necessary to require a Laser Safety Officer (LSO) to oversee the operation, maintenance, and service of Class 3b and 4 lasers. ANSI Z136.1 (2007) defines the LSO as the person with the authority and responsibility to monitor and enforce the control of laser hazards. In addition, the LSO evaluates laser hazards and establishes control measures. [5]

Dr. David Sliney (left) discusses a laser safety problem with a student at an LIA laser safety course in 1975.

LASER SAFETY TRAINING EMERGES

It is interesting to note the first laser safety guidelines developed in the United States date back to around 1966 from Bell Laboratories, other government laboratories and the Surgeon General of the Army. Later, more complete guides were developed, including the Army/Navy medical technical bulletin issued in 1968 [5], and an Air Force publication about the same time. [5]

The origin of the first two international laser safety conferences can be traced back to 1968-1970 held at the University of Cincinnati and organized by Dr. Leon Goldman and Jim Rockwell of the Children's Hospital Laser Laboratory. Following these conferences, the first laser safety courses were held at the University of Cincinnati and organized by Rockwell, which were funded by a U.S. Army Field Safety Agency grant to provide laser safety training to Army laser technologists and safety specialists. When this group of courses were completed for the Army safety community, Rockwell decided to offer virtually the same course to non-military persons under the University of Cincinnati and co-sponsored by LIA. This was the forerunner of the current LIA LSO courses.

As the market for lasers continued to grow, so did LIA and its role in laser safety. The demand for safety training prompted LIA to completely overhaul its laser safety training program in 1988 with a completely revised one-week course. In 1997, LIA assumed ownership and management of the International Laser Safety Conference, which has become the world's top forum on laser safety.

Now, LIA provides highly specialized training in laser safety for medical, research and industrial applications. In 2002, the Board of Laser Safety was formed as a nonprofit organization affiliated with LIA. It offers two types of certification, which are Certified Laser Safety Officer and Certified Medical Laser Safety Officer.

MEDICAL SURVEILLANCE

The occupational health viewpoint on the requirements for medical surveillance of laser workers has evolved continuously over the past 40 years, with requirements gradually being reduced or eliminated as more confidence evolved that there were not unexpected ocular effects that would show up in workers. A major transition took place after an international conference on laser medical surveillance was held in 1985 in Maryland.

LASER SAFETY IN THE MEDICAL FIELD

Shortly after the development of the first laser in 1960, experimentation began with lasers in surgery and medical procedures. Initial applications of lasers in ophthalmology started between 1965 and 1970. These early applications of medical and surgical lasers utilized large open beams. Doctors were required to wear goggles and had to be trained in laser safety. It wasn't until the 1980s that lasers became prevalent in general surgery applications.

Published in 1988, ANSI Z136.3 Safe Use of Lasers in Health Care Facilities was developed specifically for those working in the health care environment including hospitals and medical centers.

One of the most promising advances fueling the continued widespread use of laser applications in medicine is the delivery system of the laser itself. Manufacturers of delivery systems have become increasingly more sophisticated with safety measures, creating enclosed devices that deliver the laser contact directly to the skin—virtually eliminating the potential hazard associated with an open beam. This innovation protects the patient, nurse or doctor, and the spa employee administering wrinkle or hair removal treatment.

LASER SAFETY TODAY

Today, as lasers have become more reliable and affordable, they are being utilized in almost every field including material processing, construction, medicine, communications, energy production and national defense. [5] Even automobile, aircraft, and boat manufacturers are using lasers to increase productivity and save cost.

As a result, laser safety programs are being implemented in a wide variety of organizations and work environments. With the goal of keeping the workplace safe from hazards associated with lasers, LIA formed a cooperative program with the Occupational Safety and Health Administration (OSHA) in 2005. The program provides guidance, and access to training resources to help organizations protect their employees' health and safety by reducing and preventing exposure to laser beam and non-beam hazards in the workplace.

More recently, the use of many laser devices in the consumer world raised safety questions. However, retail products such as laser printers, copiers and scanners emit low power levels with enclosed beams to assure Class 1 products, thus eliminating the hazard.

Another significant development in recent years is that manufacturers are addressing safety issues earlier in the research and development process. In addition, laser safety design has become more sophisticated in recent years. In fact, even the military is building safer laser rangefinders, designators and training devices.

LOW PROBABILITY OF INCIDENT

One of the most important observations regarding laser safety is, generally, the probability of an incident occurring is low. On one hand, this helps the laser technology move ahead in open-beam research applications, but, this feeling of "it won't happen to me" can also lead to complacency—all the more reason to keep laser safety "top-of-mind" with continuing education and training.

Even today, it is difficult to determine how many laser-related injuries occur each year because several industries do not have mandatory reporting requirements.

In 2008, a new set of exposure limits were issued for the first time by the American Conference of Governmental Industrial Hygienists (ACGIH) [7]. This is partially due to the fact that lasers have gradually evolved, becoming easier to use. It is expected that ANSI and the international laser community will ultimately adopt these new limits with few changes.

So, why is it important to take a look back at the history of laser safety? After 40 years, what is the key to laser safety? We believe the continuing education and training of those who work with lasers is the answer. The more educated they are, the better protected they will be long-term.

Moving into 2018, laser use is ever expanding and today we have laser printers that create objects right before your very eyes. Medical surveillance is no longer required in the ANSI Z136 series of standards. Laser illumination of aircraft by people with laser pointers has gone from 949 illuminations in 2008 to 6753 illuminations by the end of 2017.

2018 UPDATE

Ten years since this article was originally penned, we are now in our 50th year of providing laser safety education. Laser use is ever expanding and today we have laser printers that create objects right before your very eyes. Medical surveillance is no longer required in the Z136 series of standards. Laser illumination of aircraft by people with laser pointers has gone from 949 illuminations in 2008 to 6753 illuminations by the end of 2017.

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LEARN MORE

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XVT™ Technology
OK
Reset
See in FULL COLOR.
Optical Density (index)
0
1
2
3
4
5
6
7
380
480
580
680
780
880
980
1080
1180
Wavelength (nm)

LASER INSTITUTE OF AMERICA NEWSLETTER

Published Quarterly by the LIA

VOL. 1 – No. 2 | 4100 EXECUTIVE PARK DRIVE, CINCINNATI, OHIO 45241 | JULY 1974

LIA MAKES FINAL PLANS FOR "GOOD–OF–MAN" EXPOSITION DURING LASER WEEK IN SAN DIEGO

Mayor Pete Wilson's Office of San Diego, California issued a proclamation on June 4th that the week of August 18-24, 1974, be considered a Laser Week "For the Good-Of-Man." Upon invitation of the San Diego Chamber of Commerce, the Laser Institute of America is sponsoring the main public exhibition on the general theme of the Applications of the Laser "For the Good-Of-Man." This will be held at the El Cortez Convention area and will be open to the general public for a nominal admission charge. All LIA members are admitted free-of-charge.

Exhibits are being sought from all sectors of the laser community to display the broad use of lasers. Exhibits are now planned which will show the use of lasers as teaching aids in schools, material processing in industry, pipe laying and other construction applications, communications, earthquake detection, oceanography, general biomedical uses, and much more. Special exhibits are also planned by key government agencies involved in the safety aspects of lasers. Plans also include the continuous showing of films on the uses and background of lasers.

Concurrent with the "Laser Week" program will be the 18th Annual Symposium of the Society of Photographical and Instrumentation Engineers (SPIE). Their meeting will be held at the nearby Town and Country Convention Center.

Exhibits of the applications of the laser in biology and medicine will be presented at the School of Medicine of the University of California, at La Jolla. These will include detailed exhibits of the laser treatment in cancer, burns, eye diseases, biology and acoustical holography.

The science of the laser will be displayed at the Fleet Hall of Science in nearby Balboa Park. Here, also, some phases of "laser art" will be shown in a comprehensive exhibit which will blend advanced laser technology into the area of art and design, etchings, paintings, ceramics, sculpture, holography, and photography. As an added attraction, there will be laser sky designs by noted laser artists Rockne Krebs, of Washington, D.C., and Ed Perry of the Department of Sculpture, University of Cincinnati.

To open this fabulous week, the city of San Diego is arranging a gala opening night ceremonies at the Space Theater of the Fleet Hall of Science. The feature speaker of that evening will be Dr. Arthur Schalow, Head of the Physics Department, Stanford University.

At this time, exhibit space is still available for companies, research departments, schools . . . etc. to display their own unique uses of lasers. As sponsors, the LIA has attempted to keep the expense of presenting your exhibit to a bare minimum. The only cost is a nominal charge for the exhibit agent's service. For more information on how you can present your story at "Laser Week", contact Mr. Ronald Dreffer, Exhibition Chairman, either by writing to the LIA headquarters or phoning: (513) 559-4405.

PETE WILSON
MAYOR

June 4, 1974

Delegates and Visitors to the Laser
For The Good of Mankind Conference

I am very pleased that San Diego has been chosen as the host city for this ambitious week of exhibits, seminars and lectures designed to conclusively demonstrate that lasers are a beneficial tool for use by mankind. For too long, I think, lasers have been popularly, but unfairly, characterized only as instruments of destruction. I am happy that San Diegans will have this opportunity to learn more about the positive ways that lasers can be applied in the varied fields of medicine, oceanography, zoology, communications, art, music, among others.

It is important, I think, that the public understands that Southern California is the center of laser technology that has permitted man to accomplish such feats with lasers as the dredging of bays, the laying of pipe, all manner of construction work, and even for satellite tracking. I look forward to learning of the numerous other applications of lasers for the good of mankind.

I am pleased to proclaim August 18 through 24 as "Laser For The Good Of Mankind Week" in the City of San Diego, and to help you in any way accomplish the goal you have established to teach the public about the many valuable contributions lasers make in our society.

My best wishes to the distinguished scientists who will join us for this week of events, and my every wish for a successful program.

Sincerely,

Pete Wilson

PETE WILSON

PROCLAMATION
MAYOR WILSON

LIA CO–SPONSORS TWO SHORT–COURSES – DETAILS ON PAGE 3

DAVE BELFORTE NEW LIA BOARD MEMBER HEADS PUBLIC RELATIONS

One of the three current vacancies on the LIA Board of Directors was filled at the June Board meeting when David Belforte was elected to fill a term through 1976. Dave, Manager, Laser Department for Ferranti Electric Inc., Sturbridge, Mass., brings with him a wealth of experience in promotional concepts - so much so - that Dave will serve as Chairman of the LIA public relations committee. Dave plans a wide-spread "PR" effort for LIA and will report his exciting promotional plans at the August board meeting. Anyone wishing to assist Dave can contact him at his office at Ferranti Electric (617) 347-7316.

MEMBERSHIP CARDS AND DUES REMINDERS SENT

All members who have paid their 1974 dues (as of June 15th) should have received their 1974 dues card. If you did not - let us know and we will immediately send a new one. As was indicated in the dues card mailing, your card is valuable and can provide you with many cost-saving advantages this year. Note that your membership number appears on your card - this number identifies your account and should be used in all ordering or registrations when membership discounts apply.

Also, a "second reminder" dues notice was sent to those 1973-LIA members who have not yet paid their 1974 dues. If you haven't paid - please do so immediately. It helps the LIA and it's really to your advantage to take advantage of the many money saving opportunities the LIA provides its membership.

LIA MEMBERS VOICE APPROVAL FOR NEW "OFFICIAL PUBLICATIONS"

The 1974 officers have received numerous comments about the recent efforts to improve communications with the LIA members through two new "Official Publications" — The E-OSD magazine and the LIA Quarterly Newsletter. One such comment recently arrived in letter form at LIA headquarters from David N. Sellers of Laser Research and Development, Inc. Dave wrote in part:

> "I would like to congratulate LIA for selecting E-OSD as the official publication, which has already received approval in the past for its outstanding coverage of the laser area both in government and industry markets. Recently, the initial copy of the Laser Institute of America Newsletter was received, and has been made available via internal distribution, receiving an overwhelming favorable response."

Dave then concludes:

> "Again, congratulations on your two latest achievements in bridging the communications gap between LIA and the membership."

Dave, we thank you and so many members like you who have recently taken the time to indicate approval (and disapproval) of what your officers and board of directors are trying to do. Communications is a two-way route - you know - and we urge LIA members to write and tell us their impressions and to give suggestions of what they feel LIA can do to aid them in their professional life in the laser community.

PRESIDENT ROCKWELL TO SPEAK AT NATIONAL SAFETY COUNCIL MEETING REPRESENTING LIA

LIA President R. James Rockwell, Jr. has been invited to speak before the "Research and Development Section" annual congress of the National Safety Council on October 1, 1974. Jim, who will represent the LIA in his presentation, will speak on "A Review of Current Laser Safety Legislation and Practices". This presentation will be an update of his earlier talk on laser safety which he presented at the 1972 NSC Congress. Incidentally, reprints of his 1972 talk are still available and may be obtained by writing the LIA headquarters and requesting the 1972 "What's New in Laser Safety" reprint.

NEW LIA LOGO SOUGHT FROM MEMBERSHIP

The LIA Board of Directors, at its March meeting, requested Board member Don "Doc" Pierson to direct a contest for a new logo for LIA. While a few old LIA'ers have some nostalgic feelings for the "little man" logo (it is supposed to be an arrow — or som[illegible]ing like that) the board decided to let the LIA members come u[illegible]h a new logo design. So — if you are artistic and if you have an idea for a logo which you feel more appropriately depicts the broad scope of LIA activities in lasers — draw it up on a standard 8 ½ x 11" page and send it to Dr. Donald Pierson at the LIA headquarters (see address above) before July 31, 1974. A distinguished panel of art critics (The LIA Executive Committee) will select the winner. Incidentally, this august group cannot enter the contest and their decision is final. You may submit as many entries as you wish, but you must be a LIA member to be eligible. The winner (who releases all rights to the design of the logo to the LIA) will be announced at the Electro-Optics '74 show. And to make it all worthwhile a $25 cash prize will be given for his effort. Good Luck!

REVIEW OF JUNE BOARD MEETINGS

To accommodate the vast geographical spread of the distinguished LIA Board, two meetings were held in the month of June. The first, chaired by President Rockwell, was held in Wheaton, Maryland on June 5th (concurrent with the NBS—BRH Laser Emissions Seminar) and the second, chaired by immediate past-president Bert Bernard, was held in San Francisco, California on June 12 (concurrent with the Quantum Electronics Conference). The following are the highlights of those meetings:

ROCKWELL and SLINEY TO SERVE ON TWO INTERNATIONAL LASER SAFETY COMMISSIONS

It was announced that Dr. Michael J. Suess, Regional Officer, Environmental Polution Control of the World Health Organization has selected two LIA Board members R. James Rockwell and David Sliney as two of the consultants to the Working Group of the scheduled WHO meeting on Health Effects of Laser Radi[illegible] to be held in Dublin, Ireland Oct. 21-25, 1974. Dr. Sue[illegible] requested that President Rockwell also be the official represen[illegible] to that meeting from the LIA. The Board of Directors ratified this request at the June Meetings.

Mr. Rockwell and Mr. Sliney, who serves as Chairman of the LIA Laser Safety Committee, also serve as technical advisors to TC—76 committee of the International Electro-Technical Commission. Dave attended the first meeting of the TC—76 committee June 19-21, 1974 in Baden-Baden, Germany. Dave plans to report details of this and other laser safety standards details in the November issue of E—OSD.

NEW MEMBERSHIP CLASSES PROPOSED FOR LIA

A new membership class was proposed and accepted by board vote at the June meetings. The new class is to be called "Institutional Membership" and this will serve to allow Universities, Private research foundations and other non-profit companies to participate in corporate membership benefits at the reasonable cost of $50.00 per year. This classification was recommended after a detailed study of our current LIA membership which disclosed numerous LIA members representing such institutional groups. The different packages to be offered the Institutional Membership Class will be considered by the Executive Committee prior to the August Board of Directors meeting.

E—OSD – LIA CONTRACT RATIFIED

The formal contract with Mr. Milton Kiver, publisher of the E—OSD Journal and the LIA was ratified by the board. The contract provides the following key features for the LIA membership:

The LIA will have up to two pages per month in the E—OSD magazine to publish material of our choice.

The LIA logo and the phrase "The Official Publication of the Laser Institute of America" will appear on the front cover of the Journal.

Each LIA member (student, regular, or corporate designee) will receive a copy of each monthly issue.

LASER INSTITUTE OF AMERICA NEWSLETTER

Published Quarterly by the LIA

VOL. 1 - NO. 3 | 4100 EXECUTIVE PARK DRIVE CINCINNATI, OHIO 45241 | SEPTEMBER 1974

LIA TO HOST MEMBERSHIP AT A GALA SOCIAL HOUR IN SAN FRANCISCO

SOCIAL HOUR NOVEMBER 6

Plans for a gala social-hour program are included in the schedule of LIA events during the EO-74/International Laser Symposium to be held in San Francisco, November 5-9, 1974.

All current members are welcome to attend the LIA social hour — and we even promise to have Laserman there as a special r··ded attraction!

The social hour is planned for Wednesday, November 6th, at 6:30 P.M. at the Townhouse Hotel (at Market & 8th Streets), nearby to the San Francisco Civic Center site of the EO-74 Symposium.

MEMBERSHIP DRIVE — PRIZES

The social hour will be the focus of an LIA membership drive planned by Greg Gregson, Chairman of the LIA membership committee. Each individual who signs up for 1975 LIA membership **at the EO-74 Show** (individual memberships cost $10 per year) will receive all of the following:

* **FULL LIA MEMBERSHIP** for the remainder of 1974 and all of 1975.

* **TWO FREE HOLOGRAMS** — one of a model airplane — and one of chessmen. The holograms are provided through the generosity of Art Johnson, president, Energy Technology, Inc. The two holograms are worth five dollars!

* **A "CHANCE"** at one of five gift certificates worth up to $100. The certificates entitle the winner to a 10% discount on up to $1000 worth of standard Energy Technology Products (except lasers). Again this is provided by Art Johnson and ETI.

* **AN INVITATION** — with two FREE drink tickets to attend the LIA social hour November 6th. Drawing for the prizes will be done at this event.

* **AN OPPORTUNITY** to meet Laserman and wear his official badge.

A FULL TECHNICAL PROGRAM PLANNED AT EO-74 — see page 2

Newsletter

News and Comments from The Laser Institute of America

VOLUME 5, NO. 1 PUBLISHED SIX TIMES A YEAR FEBRUARY, 1983

ICALEO '83 UPDATE

With program committee members selected for each Symposium of ICALEO '83, plans have been set in motion to review abstracts and summaries for the technical sessions. The LIA is soliciting contributed papers for original work of recent origin on heretofore unpublished results in the R & D of applications and the implementation of those applications into areas covered by the six ICALEO Symposia. Following are the Symposia topics and their committee members:

Lasers in Medicine and Biology

Chairperson
Rocco V. Lobraico
Midwest Bio-Laser Institute

Committee Members
Michael Berns, University of CA at Irvine
Leonard J. Cerullo, Northwestern University
Vernon Jobson, Bowman Gray Schl. of Medicine
Robert Ossoff, Northwestern University

Materials Processing

Chairperson
E. A. Metzbower
Naval Research Laboratory

Committee Members
Michael Bass, University of Southern Cal.
Stephen Copley, University of Southern Cal.
Marshall Jones, General Electric
Stanley Ream, Battelle Laboratories
William Steen, Imperial College, London

Inspection, Measurement & Control

Chairperson
Warren H. Stevenson, Purdue University

Committee Members
A. K. Bejczy, California Institute of Technology
Jack Fleischer, Photon Technology
Randal L. Schmitt, Western Electric Company
Tom Stapleton, General Motors Technical Center

Optical Communications

Chairperson
Suzanne R. Nagel, Bell Telephone Laboratories

Committee Members
A. Glista, Naval Air Systems Command
J. Goell, Lightware Technology
M. Hudson, Valtec Corporation
J. Hsieh, Lasertron
D. Jablonowski, Western Electric

Laser Chemistry, Spectroscopy and Other Scientific Applications

Co-chairpersons
Robert Godwin, Livermore National Lab
Jack Aldridge, Los Alamos National Lab

Committee Members
Wayne Johnson, Sandia National Lab
Clyde Layne, Sandia National Lab
Robin S. McDowell, Los Alamos National Lab
William C. Stwalley, University of Iowa

Information Processing and Holography

Co-chairpersons
Milton Chang, Newport Research Corporation
David Casasent, Carnegie-Mellon University

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LASER TOPICS — SUMMER 1988
Vol. 10 No. 3

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Laser Institute of America
5151 Monroe Street
Suite 102W
Toledo, Ohio 43623
(419) 882-8706
Published quarterly for its members by
Laser Institute of America
Haynes A. Lee, General Manager
John R. Dyer, Editor

Cover Photos

People In Action articles this month are illustrated by (top left) Cover of new Journal of Laser Applications; (bottom left) Schawlow Award winner Dr. L'Esperance demonstrates photocogulation by tunable dye laser as an office procedure; (bottom right) Laser biostimulation effects are subject for discussion.

President's Message

New Directions Committees Making Progress

Michael Bass
Laser Institute of America

THE process of finding a new General Manager is under way. Advertisements were run during June seeking a person to work with LIA and to make it grow. I am happy to report that several very highly qualified candidates have submitted their applications and will be considered by the Executive Committee in its role as search committee. The Executive Committee will meet in Orlando on September 24 to hold a business meeting and, if all goes well, to interview the finalists. Assuming a candidate is selected and that person and the LIA reach a mutually satisfactory agreement, we should be able to introduce the new General Manager to you at the annual meeting, at the time of ICALEO, in Santa Clara. If you have any inputs to make on this subject, please contact me or Fred Burns through the LIA office.

Dave Belforte is chairing the committee considering possible new sites for the LIA offices. The Board of Directors instructed this committee to study such issues as the presence of local laser and electro-optic industrial and educational facilities, accessibility and operating costs amongst several other criteria. The committee will also consider the ideas of the new General Manager on the subject of relocation of the offices and submit its recommendations to the Board at its meeting during the ICALEO conference. Please contact either Dave or me with any suggestions or comments on this issue.

The LIA Journals Committee, under the vigorous leadership of former President and current LIA Publications Chairman Sid Charschan, has made major progress in developing a plan for the long-awaited *Journal of Laser Applications* (JLA). The JLA is intended to become the most important repository for both recent and archival articles concerning laser applications and the devices that make them possible. All articles would be refereed to assure their quality and relevance to the JLA and to the LIA membership. Sid and his committee have developed an outline for the JLA, identified important types of articles for inclusion and, perhaps most important of all, secured commitments from many distinguished scientists, engineers and physicians from several countries to serve on the topical editorial boards.

The Journal would carry articles on such applications of lasers as materials processing, medical and surgical devices and techniques, diagnostics and controls. Other applications will be included according to the content of the articles submitted to the JLA. The full plan for the *Journal of Laser Applications* was studied by the Executive Committee during the summer so that this essential LIA initiative can be implemented as soon as is feasible. If all continues on schedule (see opposite page), the inaugural issue will be published this fall. Again, we need your comments on this subject. Please contact me or Sid or any Executive Committee member with your ideas, comments or contributions.

The upcoming ICALEO in conjunction with the OPTCON Exhibition and the concurrent meetings of OSA, IEEE-LEOS and SPIE in Santa Clara, CA, in the beginning of November promises to be a truly outstanding meeting. Attendees will learn new concepts and techniques, see their friends and colleagues and view one of the most important exhibits of lasers and laser-related equipment ever assembled. I hope you are planning to be amongst them. This will be the first OPTCON and as such is an historic event in the annals of the laser community. I look forward to seeing you there. ▲

Spring 1997
Volume 5
Number 2

LIA TODAY

The Official Newsletter of the Laser Institute of America
The professional society dedicated to fostering lasers, laser applications and laser safety worldwide.

International Laser Safety Conference Continues Tradition of Education, Training, and Networking

By Danialle Weaver

More than 200 of the world's top safety professionals from ten different countries met during the 1997 International Laser Safety Conference (ILSC '97), which was held March 17-20 at the Renaissance Hotel-Airport in Orlando. The comprehensive, four-day conference featured discussions of all aspects of laser safety practice and hazards control, including more than eighty presentations applicable to medicine, industry, research and education. ILSC '97 also featured five extremely popular hands-on laser safety workshops covering the fundamentals of laser safety: federal product requirements, hazards analysis, ANSI safety standards and setting up safety programs for industry, medicine and research.

"Things are going famously," enthused ILSC general chairman Jerome Dennis during a break in the meeting. "I'm delighted at the number of people here, and some good stuff has materialized," said Dennis, of the Food and Drug Administration's Center for Devices and Radiological Health. "We've got great sessions, a good complement of exhibitors, and a lot of enthusiasm."

Dennis said he was particularly pleased with feedback he received as instructor of the most popular workshop of the conference, which discussed the federal requirements for laser product manufacturers and some of the finer points of the regulations. Interest was high, and the workshop was packed. News that the FDA planned to put some safety information on its web site (http://www.fda.gov/cdrh *or go to* www.cdrh.fda.gov) was greeted warmly by the participants, as was the news that members of the various American National Standards Institute committees are excellent resources for those in the industry who may have particularly thorny questions. Dennis suggested that whoever needs to contact ANSI committee members should contact LIA. "LIA knows who's active," he said.

> **"Overall, the ILSC was a huge success."**
> – David Sliney
> President, Laser Institute of America

In addition to the presentations and workshops, LIA honored the memory of laser safety great George M. Wilkening by presenting the first George M. Wilkening Award to William T. Ham of Richmond, Virginia. Dr. Ham's groundbreaking research helped to literally write the book on ocular hazards presented by lasers and other high-intensity light sources. Although Dr. Ham was unable to attend the conference, his daughter and grandchildren were in attendance and accepted the award on his behalf.

Those who attended the opening reception on March 17 were treated to a special laser light show presented by Greg Makhov of Lighting Systems Design, Inc. Makhov also impressed

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Jerome Dennis (right) presents David Sliney with one of the ILSC '97 Session Chair Awards.

Laser Pioneers

An Interview with Michael Bass, Ph.D

By Chrys Panayiotou, Ed.D
Executive Director and Principal Investigator of LASER-TEC

About the Author

Dr. Chrysanthos Panayiotou is the Executive Director and Principal Investigator of LASER-TEC, a National Science Foundation Center of Excellence in Laser and Fiber Optics Education. He is also a professor and chair of the Electronics Engineering Technology Department at Indian River State College, Ft. Pierce, Florida.

Michael Bass received his PhD in Physics from the University of Michigan and is Professor Emeritus of Optics at UCF/CREOL. He entered the study of lasers in 1961, when the first laser was demonstrated, and he was the first to use a laser in his thesis studies. Before coming to UCF/CREOL, he first worked at Raytheon Corporation, and afterwards, established the first Center for Laser Studies at the University of Southern California. Dr. Bass is a Past President of LIA, Fellow of both the Optical Society of America and the IEEE, and a recipient of the RW Wood prize from the Optical Society of America.

I talked to Dr. Bass about his personal experiences in the early days of the invention of the laser and his journey through the last 60 years of laser history.

Chrys Panayiotou: Dr. Bass thank you very much for allowing us to come to your home to interview you for the series that will be published in the LIA Today magazine which is called "Pioneers in Lasers and Photonics". It will be a series which hopefully will inspire, encourage, and motivate young kids to explore this new field of photonics and lasers. So that's the whole motivation for this series. And so we thank you for allowing us to do this.

Michael Bass: Ok.

CP: Could you tell us a little bit about yourself and where you were in your life when all of these exciting things were happening, in the 50s and early 60s, when the first laser was invented?

MB: First, I should point out that while I was in high school the laser had not yet been demonstrated. In fact, optics was a "backwater" of Physics. It was really not considered the main subject of Physics. So in high school I took physics, I took science, I took chemistry, math - the usual stuff. My high school was what today is called a STEM school. It was Stuyvesant High School in New York City. And so I was exposed to the subjects of science, to the material that would generally make you say "I want to be involved in science."

I went to undergraduate school at Carnegie Mellon, it was Carnegie Tech in those days, and as an undergraduate was too busy taking undergraduate classes to be aware of the Townes and Schawlow paper that came out in the late 50s. When I was a senior, I went to a seminar by Professor Peter Franken from the University of Michigan to hear what he was doing at Michigan; and then I spoke with him about coming to Michigan as a graduate student, along with several other applications I was going to make. Well, I did go to Michigan as a graduate student - turns out he was the advisor for first year graduate students. And he decided that I should take three very difficult courses. Well I had been taking 24 units a semester for the previous four years; nine units was like a vacation! So I did very well. He said I should look around for what research I should do, and I managed to see the fellow that was working on second harmonic generation using a ruby laser. And I thought: oh my gosh, anything that could produce that much light had to be worth studying. So I said to Franken, if I could work with the ruby laser, I would be happy to be his student, and he said that's a good idea, and that's how I wound up working in lasers ever since the Spring of 1961.

Now, that was so early in the field of laser work that the ruby laser which had only just been demonstrated by Ted Maiman, was the only laser around. In the next ten years, all other types of lasers were demonstrated. And interestingly enough, all but one were demonstrated by people working in industry. Why? Because industry had the flexibility to jump into a subject that university people did not have. So the state of technology at the time, in the '50s and '60s, was that you needed to have resources to make the switch from what you had been doing to this new and exciting field of optics with lasers.

Lasers provided a potential that no one had realized yet, but that they surely had. One of the first applications that people thought about with lasers were: 'hey, they make a lot of energy, a lot of power. Maybe they could be the death-ray that had been shown in the comic books'. Well, lasers were the kind of things that were so crude that you really couldn't do very much with them, and ruby lasers only worked every thirty seconds because they had to cool off. However, some people had an application at which one shot every 30 seconds was a very high speed.

Almost everyone has forgotten the main initial application of lasers. And I'm sure you don't remember it either. It was drilling holes in baby bottle nipples. You screw up your head, and look like: why is that? Well, baby bottle nipples are made of a very soft rubber. And to drill the holes for sucking and releasing the air, so the baby doesn't suck on a vacuum, involved using hot needles. And the hot needles would often - they'd melt the rubber, but the rubber would stick to the needles, and close up the holes on the way withdrawing the needles. So the people who made baby bottle nipples came around, discovered that the ruby laser would drill these holes perfectly nicely, and you could divide the beam up into 6 or 7 or 8 separate beams that would all drill all the holes at once.

So you could drill all the holes in a baby bottle nipple once every thirty seconds. That was faster than doing it with hot needles. So off they went with a ruby laser to drill holes in baby bottle nipples. And we all grin about it, but there would have been a lot of very unhappy babies if this technique hadn't been developed.

Maimain ruby laser components

Well, as other lasers came along, other techniques than ruby lasers were developed for drilling such holes. But it just shows you that applications of laser technology are often determined by another reason than just the laser. In this case, it was the material that they had to deal with. So, early on, lasers were considered to be a solution in search of a problem. And so we didn't know what would come, but we all knew something was going to happen. That was one.

CP: Looking back, you mentioned NY, and then speaking to the professor at Chicago; how did you eventually get into this field and where did you get your degrees - your higher education degrees?

MB: Well, as I mentioned, I had gone to undergraduate school at Carnegie Tech, which was in Pittsburg, not Chicago. And then from there I went to the University of Michigan, and I worked with Peter Franken, in the initial work in non-linear optics. He had shown, prior to my getting there, that you could double the frequency of a ruby laser. That was the first demonstration of non-linear optics. When I began to work with him, I demonstrated adding the frequency of two lasers to get the sum frequency. I did my thesis work in showing that you could rectify a laser, an optical frequency. It's called Optical Rectification; it was a very interesting piece of physics. Later on, that subject, that idea, was applied to generate terahertz signals. And eventually it was recognized as important enough to lead to my getting the RW Wood prize from the Optical Society. So it took a long time, but it was finally recognized as having been an important contribution. So, I was moving west bit by bit, from NY to Pittsburg to Ann Arbor. After my thesis work I did a post-doc at the University of California at Berkley, with Irwin Hahn, where we were trying to do an experiment that today is straightforward but, then, we didn't realize that we needed a very coherent laser -a very narrow spectrum. And we didn't have it, nor did we know how to make it. But we did other things.

I left Berkeley after two years, like any good post-doc would, and worked then at Raytheon Company for seven years – did a lot of different kinds of things – studied solid state lasers, dye-lasers, laser damage problems. Most lasers in those years, in the late 60s early 70s, would usually destroy themselves before they would damage a target. And one of the big problems that the materials processing people and the military had was that they would want to use a laser for their applications but before the laser reached a power that would be useful, the laser would stop working because the optics would be damaged. So the problem was posed – how do we make optical materials that don't damage? And the question then was: why does laser light cause transparent materials to fail? It's a fundamental physics question. And so there, for many years, I worked on that subject. So you get an understanding that, in the early days, it was not just the laser that was of interest, but it was the materials that you used, it was the optics themselves.

People hadn't thought about optics at very high intensity. And we were talking now about gigawatts per square centimeter. There had never been such powers before. So nobody thought about it. Now all of a sudden, you needed to worry about it because you couldn't make a high power laser if the optics were going to fail. In the meanwhile, other kinds of high power densities were coming about, because fiber optics were being talked about. And even if you had a very low power laser, you were going to squeeze it down into a tiny fiber, maybe 3 microns in diameter. That led to very high power densities in the fiber. And now linear optics began to become important. So, all of these phenomena that had never been considered, became very important. And the optics community had this huge rebirth, all because of the laser providing very high power densities.

CP: Were your degrees all in Physics or in Engineering?

MB: My degrees were all in Physics. I would not be upset if you called it Applied Physics.

Because my research, more often than not, involved application questions, especially at the University of Southern CA, where I was on the faculty. I became involved with a professor, Steve Copley, in using lasers to affect materials. How did laser light affect alloy materials? How did it affect the strength of materials? These were material science questions. I had a lot of fun with that stuff. So it was applied work.

CP: Well since we are on the subject of you working in academia, why don't you just give us a brief overview of your career? You mentioned that you worked for Raytheon for some time and then you decided to go back to academia, or did you work for other companies? And give us a little overview of your professional experience.

MB: Ok. After doing the post-doc at Berkeley, I was recruited to the Raytheon Research Division, and as I said, I looked at different kinds of lasers, laser materials interactions, and laser damage projects. And I was invited by the University of Southern CA to help establish the Center for Laser Studies. Now, that was something that, in 1973, was unheard of at a university.

Universities are very stodgy places, and it was very rare that a research center at a university would be devoted to a subject like Lasers. Of course, in everybody's mind, it was a much broader subject. There were laser materials interactions, there were laser communications, there were issues of ultra-short pulses, there were all sorts of phenomena that would be studied. But the idea that there would be a separate center devoted to these issues was unheard of. So I was really a pioneer starting up such a center. And I spent almost 15 years at the University of Southern CA working with students, working with colleagues, faculty colleagues, establishing a variety of research activities. Some, the faculty themselves, worked on some together with myself, some, call it collaborations of one faculty with another, that was the whole point of such a center. In 1987, a former student of mine, whom I'm sure you

Continued on pg. 5

know – M.J. Soileau- was starting up CREOL here at the University of Central FL, called me and asked if I would be interested in being dean of engineering, which I was not. But my family had been in FL since the 1920s and I would be interested, I said to him, in the Vice President for Research position here at UCF, and to join up with CREOL, because that's where research and development and other issues that I was interested in would be conducted.

Well the next thing I know, I'm in FL, it's 31 years later, and every minute of it has been a lot of fun and a lot of satisfying work. And I can't say that I've had any regrets. It's been fascinating to see the growth of the optics field in this state. From CREOL, and what it does, to the way CREOL has reached out and helped other things get started: other companies, other organizations, and bring into the state people who will develop these activities. And I've been delighted to be part of it. So spending time in industry was very important. Spending time at a university gave me a chance to train students to interact with faculty with different knowledge base, and to expand on that, and include that in my own work.

CP: What areas in science were the most important to you in your career?

MB: Starting in high school of course, Math, Trigonometry, Physics. And I mention specifically Trigonometry because it helps you with spatial relations. If you're going to deal with an optical system, you have to understand where things - how things fit together in space. I know most people don't like to hear it. But I, as an undergraduate, had a course in engineering drawing. Carnegie Tech, the Physics Department, was part of the College of Engineering, and every engineering student had to take Engineering Drawing. In those days you got a T-square, triangles, French curves, and pencils that always went dull, and god forbid you had to erase something: the teacher didn't like it, but that was what we learned to do. Today you would use AutoCAD, you would do appropriate work like that; it's very important. So I emphasize it. I needed to know Statistics.

A very important subject if you're going to be doing experimental work - is to recognize when your data is statistically significant, or when it's not. Very important. Take as many labs as you could. That too was crucial work. I tell a little story that my two lab partners in my senior year, as an undergraduate: both went on to outstanding careers in physics, but they were both theoreticians. So as you could guess, in our little group of three, after the first lab class that we had, where the two of them did the experiment and I took the notes: it was a catastrophe.

None of the data made any sense, and many years later I can tell you, we had to cheat and create the data when we were writing up the report. After that I made sure that never again were the two of them taking the data. We all worked together on all the reports, but I was always involved with taking the data because these guys really couldn't hold a screwdriver by the right end. So you need to be able to do an experiment with knowledge of the equipment you're using and with knowledge of the meaningful – what is meaningful data and what is not. So take lab classes. In my undergraduate work there was no Optics Lab.

So today there would be, almost guaranteed. In graduate courses, Electricity and Magnetism was critical. I also got a lot out of Quantum Mechanics. Ok, that's crucial for understanding the mechanisms of absorption and emission. It was not an easy subject by any means, but absolutely essential. Thermodynamics and Statistical Mechanics proved to be invaluable. Now a lot of people scratch their head and say: oh my god, that's 19th century science. But it still applies today; you can't escape it. So I recommend people doing that. And those were things that I found important, especially the subjects that I mentioned – Statistics, and the subjects that can help understanding how things fit together in space. How do you lay out a laboratory, how do you layout an experiment, so that there's room to insert a beam splitter here or there? How do you make sure you've got enough height adjustments to get the beam in the right place? These all sound trivial, but you really have to understand the way things fit together. It's not trivial.

CP: How did the scientific community and the public react to the invention of the laser in the 1960s?

MB: Well, the response was huge. Optics had been a "backwater" prior to 1960. I shouldn't say that…after the Townes and Schawlow paper, people became aware that maybe it was possible to build such a device and there were a lot of people trying to build it. Suffice it to say that most people went in the wrong direction. Maiman went in the right direction, demonstrated a ruby laser. Very shortly thereafter, people at Bell Labs demonstrated a helium neon laser, and the race was on. Within ten years, all of the lasers had been developed and non-linear optics had been demonstrated. And that opened the doors, opened the floodgates, to a huge rush for doing all sorts of science: non-linear optics, laser development, questions of high power, mode-locking was understood. And that showed how to make short pulses. People began to think about what happens when we make very short pulses, and even shorter than that. So the science excitement was huge. As I say, until lasers became more reliable, the applications people hung back.

One example of an application that always stays with me is the description of using lasers to weld tin cans. The guy put up a sign showing tomatoes over here and tomato soup over there, and in between, a factory that took the tomatoes, made the soup, made the cans, filled the cans, and put them out on the tray. He said "However…", and then the next slide showed the cans not being made, and a mess of tomato soup all over the floor. And he said, "If the welding process doesn't work very reliably, you're going to have a mess". (Laugh) Ok? So the question of welding tin cans became crucial because it eliminated the solder. Solder has lead in it. So if you could weld the tin cans with a laser, that's great! And the reason for doing it, is not because the laser was better or best or whatever, but it eliminated the solder.

And, in fact, tin cans are welded with lasers. And the reason is that they are – the laser now, in fact in the late 70s, was already more reliable than the other equipment that went into the tin can welding facility. And then just to be on the safe side, they had one or more tin can welding systems ready to jump in if the other line were to break down. So the decisions about using lasers in applications are often driven by some requirement beyond the fact that the laser does a better job or cleaner job, or whatever. The decisions are often made for some reason that we're not aware of. The applications guy, they know what they want. And they'll come, just like with the baby bottle nipples.

CP: So did the newspapers publish new applications and talk about this new device - the laser doing these things that were not possible before? Was it common in the everyday press, and how did the general public view this development of the laser?

MB: Of course, there was the science fiction aspect that: oh the death-ray is here and Buck Rogers was right, and all of that. And that hit the newspapers fairly early on. By the end of the 60s, Scientific American did a whole issue on Lasers and some non-linear optics, and such like that. And it was done very well.

Michael Bass, 1984 ICALEO general chair (left), presenting award to Warren Stevenson, 1984 ICALEO program chair (right).

It didn't really become something the general public was thinking about. However, by the early 70s the public was using lasers by the billions in cd players, and the laser printer, well not yet, the laser printer would come in the 80s. But all these little diode lasers were beginning to appear everywhere. And soon it would become so commonplace that the average person in the public wouldn't even think about it.

CP: Did you foresee in the 60's the progress of laser technology as it unfolded?

MB: (Laugh) As I said before, in the rush of making lasers that would be useful, most of us were focused on just that - coming up with optics that wouldn't get damaged, coming up with lasers that were more controllable: Q-switch lasers, mode lock lasers, making better mode patterns, more uniform beam distributions. How the technology would go – we were all waiting for the people with the applications to define the problem. In fact, there was a period at the Bell Telephone labs - they were considering hollow tubes for carrying optical communication, when they discovered that the gravitational gradient of the gas in the tube would eventually cause the beam to drift off and basically leave the tube and not work anymore.

That's how desperate people were getting. Around the early 70s, people began to realize that fiber optics would serve the purpose, and it became clear that the transmission window in the fibers, and the diode lasers, would be able to produce light that would be carried in the fiber. And this actually became working hardware such that by 1980, the winter Olympics was broadcast on a fiber optic television network. None of us could foresee that that was going to happen because all those pieces had to come together at once. And nobody, nobody could claim to have recognized that that would happen in the 1960s. In fact, the diode lasers were terribly unreliable. The way to get reliable diode lasers was to make a batch of them and throw away the ones that didn't work. So it was all still black magic.

And if the fibers were going to be transmissive, that took a lot of research at Corning. And eventually they did make it, but they had to learn the process of how do you make a fiber with transmission so incredibly low loss, that it was inconceivable in the 60s. So it was not like we didn't know about fiber optics, nor that we didn't know about making diodes – we didn't know about making good ones. (Laugh) So, it was very hard to say: oh gee, it's going to happen. It was: oh gee, eventually it will happen; it could have been 20, 30, 40 years from now. Well now there's over 2 billion kilometers of fibers in the ground. OK? And your cell phone networks depend on fiber optic communication. And all of this stuff was completely inconceivable. The key to it all, whether it was machine tools to transport the light beam from place to place on a sheet of metal that's being cut or drilled, and the laser - making sure the optics stayed clean, or it was the fiber and the diode laser coming together. That was what made the technology go forward. And most of the people working in the laser side of things didn't really know what the technology was going to be, to bring it together. It would happen when both sides would sit down and discuss what they needed. And that didn't happen too often.

CP: Looking back now in hindsight, which of all these areas or applications of lasers amazes you the most , or you never thought that someone would find a use for lasers in that specific application?

MB: That's a very tough question. Because I tend to be amazed by almost anything that people do with lasers from the Lasik surgery in the eye to...by the by, I fully expected such surgeries to be developed. The laser is a very precise and powerful tool and it would not be - take too long, before the medical community would find applications for it. I knew that was going to come. In fact, I played a small role in that in identifying the use of lasers delivered through fiber optics into the gastroenterological system for stopping bleeding of ulcers. I did that in 1973, together with a gastro-neurologist, Richard Dwyer. So I knew medical applications were going to expand dramatically.

But what I would not have foreseen is the super-precision applications like Lasik surgery. That's a medical one. Like the precision machining done with lasers in making electronic devices. You know that's remarkable precision work, without which, without lasers, you can't do it. You want a cell phone with an LCD display- if you don't have lasers you can't do it; you don't have that display. I have an ultra-high definition television set – impossible without a laser to make the display. So these possibilities were beyond my imagination early on. And what really made it happen was outstanding optical and optics designers, who would say: ok, you get me a laser and I'll give you this kind of optical system and you can do the following. And it happened. People really know how to make great optics, and they give them the right source, and those optics will perform marvelous, marvelous work. It was just hard to imagine how good it would get.

CP: Now I'm going to ask you a question which is even harder than the previous one (laugh). What do you foresee happening in

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the future with lasers, and in what new fields of science do you see lasers being applied?

MB: Well, in science, very definitely, ultra-high field science, such as the people in Europe are talking about, where, by making very, very short pulses, which is another extremely important scientific field. What happens with very, very short optical pulses? You can watch things happen like molecular bonds forming or breaking apart. You can watch those dynamics happening. But when you make very, very short pulses you can also make very, very high electric field or very intense electric fields, very intense optical fields and you can create- you can accelerate electrons to very high speeds in these very short periods. You can start studying some rather amazing physics phenomena when you can do that. So I think ultra-high field and ultra-short pulse science is an amazing new area of scientific study.

I think in the engineering area, it's already underway: and that is expanding the bandwidth of the communications system. It's already getting overused. That they need for more bandwidth in the telecommunications system is clear. They've already done all the time domain multiplexing and wavelength domain multiplexing that they can possibly do. And now looking at spatial domain multiplexing, where they send signals in multiple spatial modes, and they have to manage the extra loss of those high-order modes, and then they also have to amplify them as they go down the fiber chain, and amplify them so that they don't crosstalk with each other. All of that all sounds so simple; it's not. It takes a tremendous engineering effort to make that happen. And let's face it, communications is probably the most, the largest industry we've got. Certainly the largest technological industry we've got. Without it, the modern world stops working. So, it's going to happen.

CP: What advice would you give to someone beginning college and unsure what to study?

MB: With an interest in Science or Engineering, I'd be sure to have them study, of course, all the Math they could get, Physics, Chemistry. As I said before, Engineering Drawing. Whether its, I can't imagine anyone teaches it the way I learned it with triangles and French curves and so on, but where you can learn AutoCAD or other computer based design programs. And make sure that you take Optics, if this is the field you are interested in. Because today, Optics is recognized as a major aspect of science and technology. It didn't use to be. It was just a long-lost piece of physics that was out there somewhere. And sometimes you would get a chance to study it; more often than not, almost no one did. Today, you need to study it because it is so integral to our modern society. So those would be my recommendations.

CP: What, in your opinion, are the keys to success for someone starting a career in lasers and photonics today?

MB: I would recommend that you keep an open mind to what happens and what seems to be coming along. Don't get trapped in one subject or one topic, but keep an open mind to what else is happening. New opportunities come along and often they involve more than one skill set. In coming about with an application, you need to know, not only that you have a laser system and an optical system, but you might need to know that the particular material you operate - that you're wanting to work with - has to retain a certain level of strength, or it's an alloy and part of it evaporates at a lower temperature than the other part. You need to pay attention to the whole picture when working on an application. So you'll need to look at the whole scene, and work with other people in coming up with a workable solution.

So, it's more than just one technology that you're going to be dealing with. And I recommend that you examine which is the key problem in any application, and work back from that key problem. For example, we were once involved with a company that wanted to enhance the self-sharpening aspect of chain-saw teeth. Ok? After we talked to them for a while, we realized that a chain-saw tooth is kind of like your hand bent over like that, and the top surface would be hard, and the bottom surface soft. So the bottom surface would wear away leaving a sharp edge. Ok? So what they wanted to do was simply put a hard layer on the top and let the bottom be the soft steel. Well, it took us a while to realize that that's all they wanted to do. We on the other hand, didn't listen, and came up with a solution that was absolutely incorrect.

And so we didn't go any further with this particular company. But if we had thought carefully, we had a good idea how to do it. But it was already too late. So I'm saying: listen to what the people with the problem are talking about, and work with them towards a solution. So those are keys that I would say. Not just in something like materials processing, but in communications, in any other photonic applications such as, you know - laser printers, laser communication devices. Heck, you hear lots of advertising about laser-measured car mats for use in your cars. Well laser measuring devices is a big application. And you have to think about how to use them, how to design them, how to make them rugged, and all of that. That's a serious application which didn't pop up in a science lab.

CP: Is there anything else that you would like to add that I haven't covered? Something that you wish we would mention and publish about the science of lasers and field of photonics?

MB: It's been said that my thesis was the first thesis to ever use a laser for doing anything. So I've been around as long as anybody in the field of optics and photonics. And I have to say that it has not yet run its course. There's a long future ahead of it, a lot of great things to be done. And I wish everybody who does get into this field a great deal of success. It's got a lot of opportunities out there and you need to consider that, as the future goes on, more and more you need to work with teams of people to get these opportunities to success. Thank you.

CP: Dr. Bass, thank you very much. We appreciate you giving us a chance to do this interview.

"You Want to do *WHAT* with a Laser?"

Little Tales of Laser History

By Paul Denney with Support of David Belforte

Curiosity is a key piece of human nature that has led to great discoveries and innovations. For the many technologies we enjoy in the modern age, we can thank the minds that dared to wonder, "What if?"

Yet, for every idea that worked, there are a thousand that didn't quite take-off, but still helped us get to where we are today.

As we celebrate the 50th anniversary of LIA this year, I have thought back to all of the lasers and laser applications that I have been involved with over my 37 years of experience in the laser industry. In all of that time, with the many different companies that I have worked with, I have seen a lot of ideas about what could be done with a laser. Some of them continued on to be implemented into current applications, while some of them only live on as stories we tell around a beer at a laser conference. In this article, I share a few of my favorite stories of novel uses of laser systems that didn't quite make it into the mainstream, but still have their place in history.

As a note before we begin, I apologize if I mention a program that you were involved in and/or miss any details. I have tried to find published sources that confirm the projects I am sharing here.

1970's

ZAPPING PLANTS!

One of my favorite stories is related to the Army Corps of Engineers. In the 1970's there were invasive plants called "water hyacinth" in the waterways of the southeastern United States. The Army Corps of Engineers were researching many different ways to address these plants that were strangling the lakes and rivers. Somehow, they came up with the idea that if they used a laser, they could "burn" the plant near the bottom. This was first demonstrated in the laboratory, and the demonstration went well enough that a laser was purchased (believed to have been a 12 kW CO2) and was integrated into a system on a barge (including a generator, chiller, power supply, and beam manipulation system). I searched for more information about the results of this project, but came up empty. The only thing that I found was in a report that stated that this did not prove to be economical.

1980's

THAT'S NUTS

An interesting food application that researchers tried to "crack" was whether lasers could be used to remove shells from nuts. It seems that the most commonly accepted method of harvesting the meat from nuts is to roll them between two steel rollers, "crack" the nut into pieces, and remove the meat. This approach is low-tech and low-cost however the shells may get embedded into the meat which makes separation more difficult. So, a guy from New Jersey thought, "What better way to fix this problem than to use a laser to 'cut' the shell without damaging the meat of the nut?" according to the patent, the laser method involves focusing the laser on the shell and spinning the nut quickly (to avoid 'cooking' the meat). While I am sure this works, I am not sure how hard it is to grab, place, and spin each individual nut, versus throwing a basket full of nuts between a couple of steel rollers. In both cases, you still have to pick out the meat. Based on my source, this has not been implemented but is an interesting approach.

2000's

DRILLING HOLES IN HOSPITALS

An odd "construction" application occurred in the early 2000's. Due to changes in earthquake building codes for hospitals in California, the Loma Linda Medical Center needed to find a way to make major changes to their existing hospital. The renovation was going to be extensive and it was going to require the drilling of a large number of holes in existing concrete structures. Normal construction methods would result in loud noises and vibrations which would disturb the hospital patients. So, of course, the obvious solution was lasers.

The hospital wondered if a laser could be used to drill holes in the concrete so rebar could be added and additional concrete poured to strengthen floors and walls. Working with a research group, they not only developed a process for laboratory demonstration, but they demonstrated drilling, cutting, and surfacing with a 4 kW Nd:YAG. This was a major effort. The concept for the system would go into a room to be used for drilling holes. The processing head would be operated by a technician and the system would not only do the processing but would provide a safe operating condition. While the process worked, the system was never fully implemented.

CUTTING THE CHEESE

So, there have been a lot of laser applications investigated for food. I've heard stories about using lasers to make "grill" marks on steaks and using pulsed lasers to "ablate" skins from tomatoes and potatoes, but I haven't been able to verify how many of these stories are true or just "industry myth". One food example that really did happen comes from ICALEO 2003. A team of students from the University of Wisconsin-Madison demonstrated that a laser could be used to cut cheese in much the same way that its used to cut metals and other materials with a 2D cutting system. The hope was that cutting slices of cheese into entertaining shapes would encourage kids to eat more cheese. To make this a reality, researchers looked at the "best" wavelength for cutting of the cheese. The students actually demonstrated how easy it was and made some rather large decorative "displays", showing how versatile the system was for "cutting the cheese". While it was possible to cut some intricate shapes with shorter wavelength pulsed lasers with what should be considered a "cold process", the cut edge of the cheese was altered enough that it changed the taste of the cheese and kind of killed the idea from going further.

THE SPACE ELEVATOR

A story that did get a lot of press was the concept of using a laser to power a "space elevator". You may recognize this concept from science fiction; the idea is to place a satellite into geocentric orbit – that means it is above the earth at 35,785 km and would appear to be stationary above a point on the earth. The famous sci-fi author, Arthur C. Clark even described this application, but predicted that it would only become practical "50 years after people stopped laughing". It would seem that people are still laughing. From a geocentric orbit, a satellite could be used to build and launch space vehicles, but you still have to find an economical way to move equipment and materials to this height above the surface. So, for the "space elevator", you would run cables from the earth to the satellite (a 35,785 km long cable) which has to support the weight of the materials you are transporting to the satellite as well as the weight of the cable itself.

The "concept guys" acknowledge that fabricating a cable strong enough is not possible today. One possible solution is to use "nano-technology" to fabricate super strong cables which can be strong and very long. So once you have a 35,785 km long fiber, how are you supposed to "string it between the earth and the satellite? It's not like you would tie a rock to one end of the cable and lower it down. And the other questions is how well does a cable stretched between two points handle the environment? How will it react to the force of the wind on it? Will it ice up?

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How would you protect the cable from accidental damage from aircrafts and what kind of safety precautions do you have for the system (you think getting stuck half way up a hill on a chair lift at a ski resort is bad, think how bad this thing would be getting stuck half way up)? But if we put all of those things aside and that you could work all those issues out, , the next problem is how to power the elevator car for a 35,785 km journey. This is where the laser comes in.

The great thing about having the satellite directly above a point on the earth is that it would be in your line of sight the whole way (except for when there were clouds). So, the concept was to direct a laser beam at some sort of “energy collection” system on the elevator car which would covert the laser light to electricity which would power the motors that would allow the elevator car to “climb” to the satellite. So, while this seems like a crazy idea, it seemed logical enough that NASA funded a contest to prove that at least the concept of using laser light to power a “vehicle” up a cable was possible. In 2009, a company called LaserMotive did just that – they built a “laser powered elevator car”, which travelled up a tethered cable and they won $900,000 (USD) in prize money. So, 1 km down, 35,784 km to go.

LASER POWERED

Another “space” application that was proposed was to use a laser to “power” a spacecraft as an alternative to using liquid or solid fuel. The concept was to direct a laser beam to a special shape capsule that would was coated with material that could be ablated by a laser beam. As the material was it ablated and “left” the surface of the capsule, it would “push” against the capsule in a forward direction giving it “thrust”. The concept that if you could keep the laser beam on the capsule for a long period of time that you could accelerate the capsule to very high velocities. This concept has advanced and has even been demonstrated on a small scale. The process has been used to “launch” and maintain a small capsule above the ground for short periods of time. While this approach seems to be technically possible, there are some practical issues that still need to be addressed. First, for space travel, it may be difficult to keep the laser beam, which may be in orbit and therefore moving, aligned on the capsule for a long period of time. Also, as the space craft moves away, even with a laser beam, the power density will fall off as the distance increases. There are a number of other issues like how do you slow down and/or steer the capsule? But at the end of the day it is really interesting to see a “capsule” go up into the air by using laser light.

TODAY

Hopefully you enjoyed these little stories about laser processing that “didn’t make it (yet)”. I would be interested in any of your “stories” so please share them with me and I promise to pass along in the future. Please send your stories to pdenney1@gmail.com.

And while I may come across as a “buzz kill” on these laser applications, I don’t mean to damping anyone’s enthusiasm for thinking up new and innovative laser applications. Instead I hope these stories encourage researchers to continue thinking up “crazy” ideas because you never know what project may spark the next big innovation.

ABOUT THE AUTHOR

Paul Denney has been involved with laser materials processing for over 37 years. He is a past president of LIA, member of the LIA Board of Directors, and is a LIA Fellow.

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Cancer Treatment in a New Light

Photodynamic Therapy (PDT)

WRITTEN BY LILIANA CALDERO
CONTRIBUTIONS BY GAL SHAFIRSTEIN, D.SC & DAVID BELLNIER, PH.D

Part 1: LITT
Part 2: PDT
Part 3: PBM

Image of fiber-optics [Image Credit: © alexskopje/ Adobe Stock]

The **National Cancer Institute**_(NCI) estimates that in the U.S., about 1,735,350 new cases of cancer will be diagnosed in 2018 alone, and according to their estimation, 609,640 people in the U.S. will die from this disease this year. Despite these overwhelming numbers, there is hope. Between 1990 and 2014, the overall cancer death rate has dropped by 25% in the U.S., and is falling a little more each year as research and technology continue to produce new life-saving procedures and treatments.

The use of light to treat illnesses predates the laser. As early as 1903, the light of a carbon-arc lamp was being researched as a treatment for smallpox lesions. It was believed then that certain light wavelengths could kill bacteria. Over the years, this new treatment called phototherapy continued to evolve alongside technology and medicine. As early as 1913, scientists were experimenting with chemicals that induced sensitivity to light (photosensitizers) to produce a therapeutic effect. Today, photosensitizers, specific wavelengths of laser light, and biological tissue oxygen are the key components of what is now called Photodynamic Therapy, or PDT.

At Roswell Park Comprehensive Cancer Center, materials scientist Gal Shafirstein, D.Sc., and radiation biologist David Bellnier, Ph.D., coordinate pre-clinical and clinical studies of PDT treatments for various forms of cancer that would otherwise have few treatment options. In part two of this three-part mini-series on lasers in cancer treatment, Shafirstein and Bellnier help us understand how this photochemical process is being used to treat cancer.

HOW IT WORKS

In short, PDT provides local control of cancer by ablating the cancer cells. A photosensitizing agent is either placed onto the skin or injected into the bloodstream. When cells containing the photosensitizer are exposed to a specific wavelength of light, a type of molecular oxygen is produced, which kills the cells. Because photosensitizers are retained longer in cancer cells than in in normal tissue, healthy cells can be spared these "phototoxic" effects. The wavelength of the light source is important to the activation of specific photosensitizers, and different types of tissue require different wavelengths, so selecting the right type of photosensitizer is important.

"The laser wavelength should be very close to the absorption maximum of the photosensitizer," explain Shafirstein and Bellnier. "Commonly used porphyrin-based photosensitizers have high absorption in the blue region of the visible spectrum (the Soret peak). However, due to poor penetration in tissue, blue light is largely used to treat very thin diseases like actinic keratosis, a common precancerous skin lesion. Since light transmission through tissue increases with increasing wavelength, most PDT of thicker malignant lesions is performed with red light, commonly thought of as 620 – 750 nm. Third generation photosensitizers with absorptions around 800 nm are being developed; this wavelength corresponds to the so-called 'optical window' in tissue where light penetration is optimal."

TEAM WORK

As scientists, Shafirstein and Bellnier approach human tissue in a way similar to how materials scientists and engineers approach other types of materials (structural, electronic, semi-conductors, etc.). “In laser therapy of cancer, pretreatment planning and light dosimetry are key factors to delivering a treatment that is effective and reproducible. The computational tools used to develop pretreatment planning are engineering-based, and largely the same as those used in the studies of laser treatment of metals. For example, we are using a multi-physics commercial software (Comsol, Comsol Inc., Burlington, MA) for pretreatment planning, by solving the diffusion equation where concentration is substituted with photon flux [5,6]. This is an engineering tool used by materials science engineers and other types of engineers.

“In laser therapies of cancer, one can replace materials properties with tissue properties to develop new systems for therapy and diagnosis. The caveat is that engineers and materials scientists must work with a team that includes biologists and physicians that can help them to define the engineering problem that needs to be solved to answer a key question in the biology. It’s true teamwork!”

THE BENEFITS

Citing numerous studies, Shafirstein and Bellnier believe PDT can have several important benefits for cancer patients. It can be used to treat early-staged cancer with minimal toxicity, as well as cancerous tumors that have become resistant to other therapies. Furthermore, clinically approved photosensitizers used in PDT have no genotoxicity. In conventional cancer treatment, genotoxic chemotherapy treats cancer with chemicals that cause damage to the DNA within a cell, potentially inducing apoptosis; unfortunately, this kind of treatment can affect healthy cells, and increases the risk of a patient developing a secondary cancer such as leukemia. They also cite studies that show specific PDT regimens may improve the body’s immune response to cancer. Like other laser treatments for cancer, recovery time is short and the targeted and local nature of the treatment greatly limits damage to healthy tissue in the treated regions, allowing patients to continue with the other therapies in their treatment plan without interruption.

As with any treatment, there are some drawbacks. Photosensitizers can cause skin photosensitivity; these patients may therefore have to limit their exposure to strong sunlight for several months until the chemicals have fully left their system. While PDT also typically preserves the functionality of the organs, it can still cause short-term pain and edema, which Shafirstein and Bellnier note can be alleviated. They point out that when the benefits and risks are taken together, PDT is “more organ sparing than many other ablative therapies.”

THE FUTURE OF PDT

In the past, PDT has been limited to treating tumors on areas of the body that could be reached with the laser light, usually the outside of the skin or the lining of certain organs. Today, there is Interstitial PDT (I-PDT), which can be used to treat locally advanced cancerous tumors deep within the human body.

“The laser light that activates PDT can be delivered through one or more cylindrically diffusing optical fibers inserted into large tumors or within deeply seated organs,” say Shafirstein and Bellnier. “Several reports suggest that I-PDT can be used to treat cancer of the lung, esophagus, prostate, head and neck, pancreas, brain, bladder, breast, soft tissue, bile duct, and vulva. With careful treatment planning, I-PDT can be used to safely and effectively treat tumors up to several centimeters in size.” For a recent review of this topic, they suggest, see Shafirstein et al. 2017[3].

LITT AND I-PDT

To those who read part one of our three-part series on laser treatments of cancer, this process may sound familiar. We learned about Laser Interstitial Thermal Therapy (LITT), which also delivers laser light in a similar manner that is meant to ablate tumor tissue. Shafirstein and Bellnier explain the difference between the two treatment types. “Since I-PDT relies on activation of the photosensitizer to induce cell death, it requires less power and energy in comparison to LITT. The activation wavelengths are typically shorter and depend largely on the photosensitizer, corresponding to absorption peaks (e.g. 630, 652 and 665 nm versus >800 nm in LITT). I-PDT can be used to treat tumors next to large blood vessels with little change in PDT effect, but would typically affect the thermal field in LITT.

“I-PDT can be used to treat fairly large tumors by using multiple laser fibers [1,2,4], where LITT is typically limited to using one fiber for the treatment of smaller tumors.”

In addition to I-PDT, the inner organs can be reached with intraoperative PDT (IO-PDT) to complement other treatments for lung cancer and malignant mesothelioma. After the tumor has been removed, IO-PDT can be used to kill any remaining cancer cells in the chest cavity by shining diffuse laser light through a laser fiber that is in a tiny balloon. It is a promising technique that may improve the survival rates of patients with malignant mesothelioma.

New research is continuing to advance the effectiveness of I-PDT. According to Shafirstein and Bellnier, recent studies are focusing on laser light dosimetry and real-time feedback to better control the laser light, and quite a bit of research is focusing on developing new treatments for cancers that do not have many treatment options.

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THE NEED FOR IMPROVED TECHNOLOGY

Shafirstein and Bellnier suggest that highly efficient multi-channel fiber-coupled laser diode systems are needed to improve I-PDT. “In IO-PDT, multiple laser fibers — typically 6 to 12, and as many as 27 — may be required to deliver an effective illumination of the tumor. To date, we insert multiple catheters into the tumor and move laser fibers between catheters to illuminate the entire tumor (see Mimikos et al. 2016)[4]. That is fairly time consuming, taking between 1 and 3 hours. Multi-channel laser systems (e.g. 8 or 12 channels) could reduce treatment time by allowing the illumination of all fibers at once. ”

As important as I-PDT is to the future of cancer treatment, the associated costs may limit the number of treatment facilities that can adopt this treatment modality. Shafirstein and Bellnier believe that developing cost-effective diode laser systems will help more hospitals and cancer treatment centers adopt the technologies and techniques needed for PDT. “The cost that we refer to is for an entire medical system for conducting I-PDT. Today, these systems are expensive, because there is a need to set up a system that includes multiple devices: lasers, fibers, dosimetry system, and treatment planning software. These medical systems require engineers and scientists for operation. We think that a cost effective integrated system for I-PDT will help more hospitals and cancer centers to adopt this technology. Research is underway to achieve that goal.”

With continued pre-clinical and clinical research at treatment centers such as Roswell Park Comprehensive Cancer Center, the future of PDT for cancer treatment is bright. Now, the challenge remains to continue improving technology and cost-effectiveness so this treatment can one day be widely available.

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About GAL SHAFIRSTEIN, D.SC

Gal Shafirstein earned his B.Sc. in the Department of Materials Science at Ben-Gurion University, his M.Sc. and D.Sc. in the Department of Materials Science and Engineering at the Technion, Israel Institute of Technology. In 2012, he was recruited as a full Professor of Oncology and Member of the Photodynamic Therapy (PDT) Center of Roswell Park Comprehensive Cancer Center, Buffalo, NY. The PDT Center at Roswell Park is a world leader in the field of PDT. Roswell Park is where modern PDT was initiated in 1970s, and the first FDA-approved drug for PDT cancer therapy was developed. Professor Shafirstein has served as Director of PDT Clinical Research at the Buffalo, N.Y., cancer center since 2015. He is responsible for developing and supporting multiple clinical studies in PDT. His research is supported, primarily, with competitive awards from the National Cancer Institute of the National Institutes of Health, USA. His research focuses on developing laser therapies for patients with cancer that have no good treatment options. https://www.roswellpark.edu/gal-shafirstein.

About DAVID BELLNIER, PH.D

Dr. Bellnier is an Assistant Member of the Department of Cell Stress Biology, member of the Photodynamic Therapy (PDT) Center and member of the Biophysical Therapies Program at Roswell Park Comprehensive Cancer Center. He also holds a faculty appointment with the University at Buffalo (UB). Dr. Bellnier earned his doctoral degree in radiation biology at UB's Roswell Park Graduate Division, and did postdoctoral training in urology research at Massachusetts General Hospital and at the Center for Advanced Laser Research at Baylor University Medical Center. Though he engages in a diverse array of cross-disciplinary collaborations, his research focuses primarily on the use of photodynamic therapy in the treatment of cancer.

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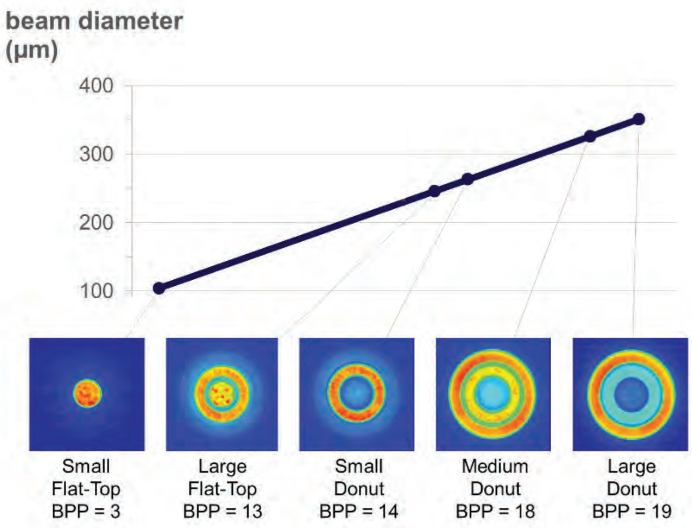
New Fiber Laser with Programmable Beam Quality Offers Dramatic Advance in Metal Processing Capability

BY DAHV KLINER (VICE PRESIDENT, FIBER LASER TECHNOLOGY) **AND BRIAN VICTOR** (DIRECTOR OF INDUSTRIAL APPLICATIONS)

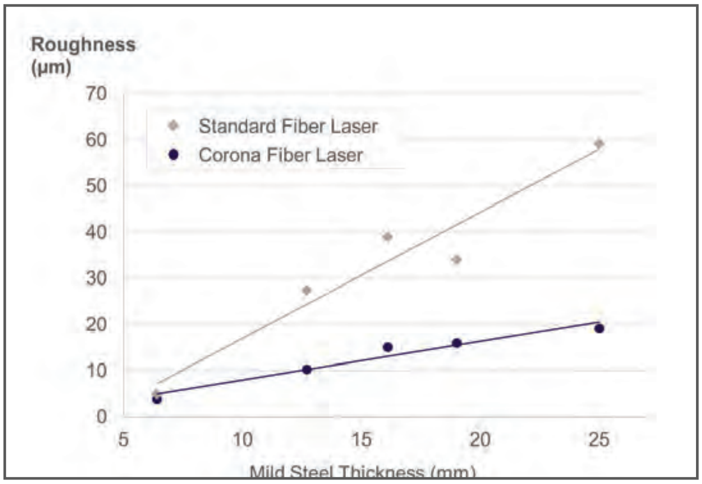
Laser-based tools have been essential for driving metal cutting productivity due to their inherent precision, speed, and quality advantages. Over the past decade, fiber lasers have become the dominant laser technology by providing an unmatched combination of cutting speed, ease of use, and low cost of ownership. For thin metals, the highest cutting speed is achieved with the smallest laser spot size (maximum power density), but the maximum thickness this small spot size can cut is limited. For thick plate, larger spot sizes are required to obtain better edge quality and consistent part removal. To cut a range of materials and thicknesses, fabrication shops have thus had to purchase multiple tools or to vary the laser spot size using free-space optical components, such as process heads with changeable or zoom lenses, fiber-to-fiber couplers, or beam switches. These approaches entail significant compromises in performance, initial and ongoing costs, complexity, and reliability.

nLIGHT® has released a revolutionary fiber laser product, Corona™, that enables rapid programming of the spot size directly from the fiber laser. This ground-breaking, all-fiber technology does not use free-space optics, eliminating their associated performance and reliability degradation and enabling optimized cutting of thin sheet and thick plate with a single laser source. This versatility is achieved by tuning the beam characteristics within the Corona laser, inside the fiber, without making any changes to the cutting head.

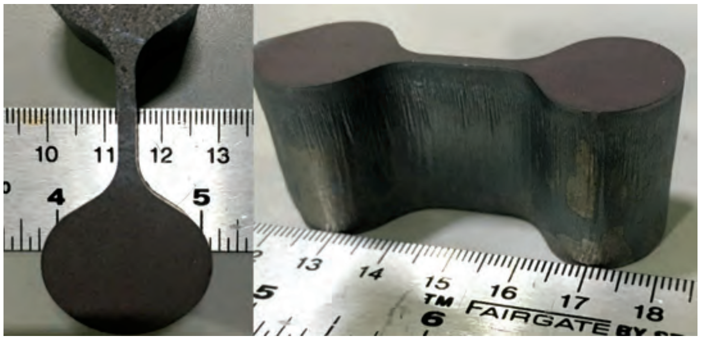


Beam characteristics of a 4 kW Corona fiber laser with five settings. The inset images show near-field spatial profiles at the focus below the process head for each Corona setting.

The Corona output beam is tunable between 100 μm and 350 μm diameter. Along this curve of programmable beam size, Corona fiber lasers offer a variety of beam shapes, including flat-top and annular or "donut" beams, that enable excellent cutting performance for a range of materials and thicknesses. Tuning over Corona's full dynamic range is performed in less than 30 ms, and the laser operates at full power as the beam profile is changed. This real-time programmability enables adjustments on-the-fly and allows optimization of each step of the process (e.g., piercing and cutting).



Standard fiber laser vs corona fiber laser



Corona enables excellent control of heat and kerf width on thick mild steel, resulting in reduced roughness comparable to CO2 lasers and the ability to cut narrow features in 25 mm plate.

Corona fiber lasers have already demonstrated dramatic performance advances over conventional fiber lasers. For oxygen cutting of mild steel with thickness greater than 6 mm, the Corona fiber laser provides significantly better edge straightness and reduced roughness, with edge quality rivaling that of a CO2 laser. For nitrogen cutting of stainless steel and aluminum, Corona enables kerf-width control for optimized melt ejection and reduced roughness and dross.

Corona fiber lasers represent a major innovation, offering tool integrators and fabricators significant advantages over both standard fiber lasers and free-space optical technologies. Corona's all-fiber programmable beam quality enables development of "universal tools" to address a range of applications with unrivaled performance, productivity, versatility, and reliability.

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nLIGHT has been serving the high-power industrial, aerospace & defense, and microfabrication markets for nearly two decades with leading semiconductor lasers, fiber-coupled pump diodes, specialty fiber, and fiber lasers. Headquartered in the Pacific Northwest, nLIGHT's fiber lasers are made in the USA.

Considering the Movement of a Laser for its Classification

Originally Presented at ILSC 2017

BY: NICO HEUSSNER, RAIMUND REPPICH, ANNETTE FREDERIKSEN (*ROBERT BOSCH GMBH)*

SCOPE

Within the development process of the international laser product safety standard IEC 60825-1 towards a more appropriate description of complex new laser devices, the case of a moving laser source (such as mounted on a vehicle) has to be considered. It is currently implied to handle such a case as scanning radiation with a stationary aperture stop, which is not restrictive enough in some cases: assuming an observer which is moving at the same speed as the vehicle, the emission duration cannot be reduced as it is done for the case of a radially scanning laser. We therefore suggest the modification of the standard which should consider a moving aperture which leads to the consideration of the full classification time base. Also a measurement aperture does not need to be placed at a distance at which no observer can be expected (due to the speed of the laser source).

CONCEPT

As a simple description of a vehicle's movement we suggest to introduce a "virtual enclosure" which mimics the inaccessibility of e.g. a car while it is moving. In more detail, we suggest to treat any platform which moves slower than 10 km/h as a non-moving platform and therefore to use the evaluation procedure of a non-moving source, i.e. to keep the platform stationary as well as the measurement aperture at the distances given in the current edition of IEC 60825-1. Above 10 km/h it is assumed that no observer is able to get closer to the moving source than the mechanical extent of the vehicle. This reflects the fact, that for a non-moving car the observer has full accessibility to the source at any position while this accessibility vanishes as soon as the vehicle moves fast enough. The concept of the mechanical extent of the vehicle and therefore of the reference points for the distance measurements for the case of classification as moving platform is depicted in figure 2 below (for tests as stationary source, the reference points of Table 11 of IEC 60825-1 apply).

In order to define the presented concept, all possible scenarios have to be taken into account. The hazard to the observer can be classified into two general scenarios: the exposure of non-moving i.e. stationary objects by a moving source (high relative speed) and the exposure of an object which is moving itself (low or no relative speed), compare figure 1.

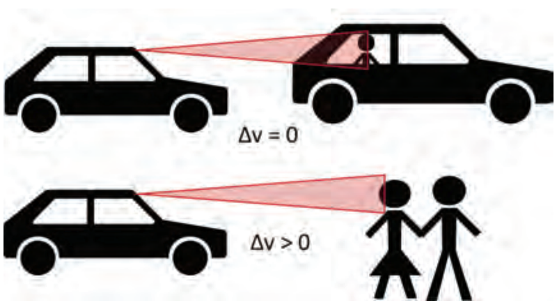

Figure 1: a) moving observer b) stationary observer

SCENARIO A) – MOVING OBSERVER:

The worst-case which can occur for this scenario is an observer staring into the moving source while moving him or herself in the same direction as the origin of the laser radiation at the same speed, i.e. moving at a relative speed of 0 km/h. The worst cases imaginable for automotive applications are passengers who stare through the rear window or a person sitting on a motorcycle looking backwards for the case that a laser is mounted on the following car pointing into the direction of movement. We propose a value of 1 m as a conservative estimation for the distance of the measurement aperture following from the limited access to the source at high speed. Assuming that the vehicle is considered as moving from 10 km/h onwards and that 1 m is the biggest distance leads to the following equation:

$$r(v) = \begin{cases} 100\text{ mm (no mech. ext. considered)} & v < 10\text{ km/h} \\ \dfrac{v - 10\text{ km/h}}{0.09}\text{ mm} + \text{mech. extent} & v \geq 10\text{ km/h} \\ 1\text{ m} + \text{mech. extent} & v > 100\text{ km/h} \end{cases}$$

Equation 1: Measurement distance for different platform speeds - [v] = km/h

Where r(v) is the measurement distance from the reference point (the closest point of human access given by the speed of the platform) in the direction of movement (forward and backward). Any measurement distance r(v) below 100 mm does not need to be considered for classification. For this case the use of the full time base for classification is obvious.

SCENARIO B) – STATIONARY OBSERVER:

Since a collision would lead to a significantly more dangerous situation, it can be assumed that the minimal distance to the aperture does not have to be considered. Therefore, the mechanical "envelope" of the car is defined by the outer edges (see also figure 1), as soon as the speed of the car is sufficient (e.g. >10 km/h), since this is the minimal distance anyone would hold while a car is moving. Below 10 km/h the minimum measurement distance is 100 mm measured from the reference point of the laser product since the car is assumed as non-moving again. Concerning the distance of the measurement aperture to the front and back it is clear that the case of a stationary observer is less restrictive than the description suggested in equation 1 since it is impossible for a stationary observer to escape from the suggested measurement distance at the discussed velocities. Therefore the dependency described in equation 1 is more restrictive and there is no need to introduce an additional measurement distance for stationary observer. In order to avoid complicated assessments, we suggest to also use the full classification time base for classifications of stationary observers. Using this assumption, the case of a stationary observer is always satisfied automatically when a moving observer as discussed under scenario a) is assumed.

EXEMPLARY SOURCE POSITIONS

To demonstrate the distances which would follow from the suggested changes to the laser safety standard, two exemplary source positions were defined in figure 2 in purple (located centrally on the roof) and red (located on side front of car); the direction of laser emission can be in any direction. For this example the side-view mirror has an extent of 200 mm. The measurement distances to the front and back direction depend on the speed of the platform as discussed above.

Distance source to aperture	Position 1	Position 2
Front	100 mm (0 km/h) 3.5 m (10 km/h) 4.5 m (100 km/h)	100 mm (0 km/h) 0.3 m (10 km/h) 1.3 m (100 km/h)
Back	100 mm (0 km/h) 1.5 m (10 km/h) 2.5 m (100 km/h)	100 mm (0 km/h) 4.7 m (10 km/h) 5.7 m (100 km/h)
Side	100 mm (0 km/h) 1.2 m (10 km/h) 1.2 m (100 km/h)	100 mm (0 km/h) 0.2 m (10 km/h) 0.2 m (10 km/h)

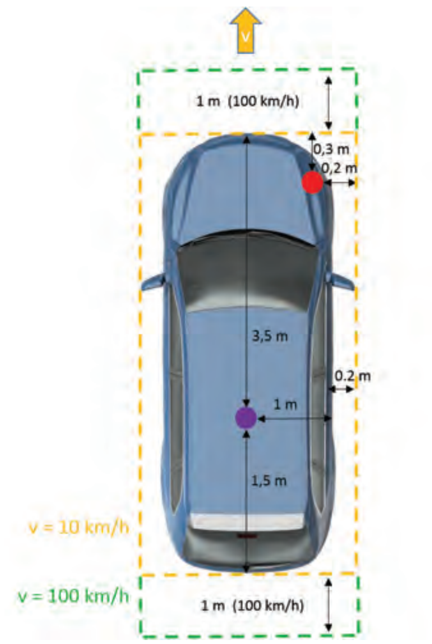

Figure 2: Concept of virtual enclosure with exemplary source positions

Table 1 shows the resulting respective distances for different vehicle speeds using the same colors as figure 2. The influence of the position of the laser within the defined CPHA (closest point of human access) box onto the total distance between laser source and the measurement aperture becomes clear by comparing the two positions.

SUMMARY

The suggested changes introduce the full classification for a moving laser source which is necessary in order to be restrictive enough in all cases. Additionally reasonable assumptions are made about the distance of the measurement aperture. In total this change results in a higher permitted emission for moving laser systems with divergent or scanning beams. This increased permitted emission might reduce the need for complex laser safety evaluations since e.g. the simplified C6=1 approach (or other simplifications which results in a reduced allowed emission) could already lead to permitted emission levels which are sufficient to ensure the full functionality of the device.

It has to be mentioned, that the presented cases always assume that the laser radiation is not accessible to an observer on the moving platform itself in any way. In this case additional restrictions might apply.

Note: During the last IEC TC 76 meeting in Sept. 2018 a proposal according to the matter presented here was extensively discussed and further developed. The initiation of an ad-hoc committee working on a "moving platform technical specification/international standard" has been approved.

Continued on next page

ABOUT THE AUTHORS

Dr. Nico Heussner studied electrical engineering with a focus on optical technologies at the Karlsruhe Institute of Technology (KIT) and the University of St. Andrews. During his PhD thesis at the FZI - Forschungszentrum Informatik he worked successfully on the modelling of retinal damage. Since 2015 he is responsible for ocular safety of lidar devices at Bosch including research topics which concern with modelling and measurements of thermomechanical damage to the retina.

Raimund Reppich studied electrical engineering at the University Stuttgart and the Karlsruhe Institute of Technology (KIT). In 2016 he joined Robert Bosch GmbH, Stuttgart, Germany as a Software Developer. In his work he is involved in the eye safety evaluation of complex laser products and aims to establish a more standardized and algorithmic evaluation and application of the norm IEC 60825-1.

Dr. Annette Frederiksen joined Robert Bosch GmbH, Stuttgart, Germany, in 2008 and works in the Corporate Research and Advanced Engineering department in the group for optics and optoelectronics. She is deeply involved in eye safety evaluation of complex laser products and actively participates as an expert in the German (DKE/GK 841), European (CLC TC 76) and international (IEC TC 76) standardization committees for optical radiation safety. She is the project leader for the topic “Moving Platform” in IEC TC 76.

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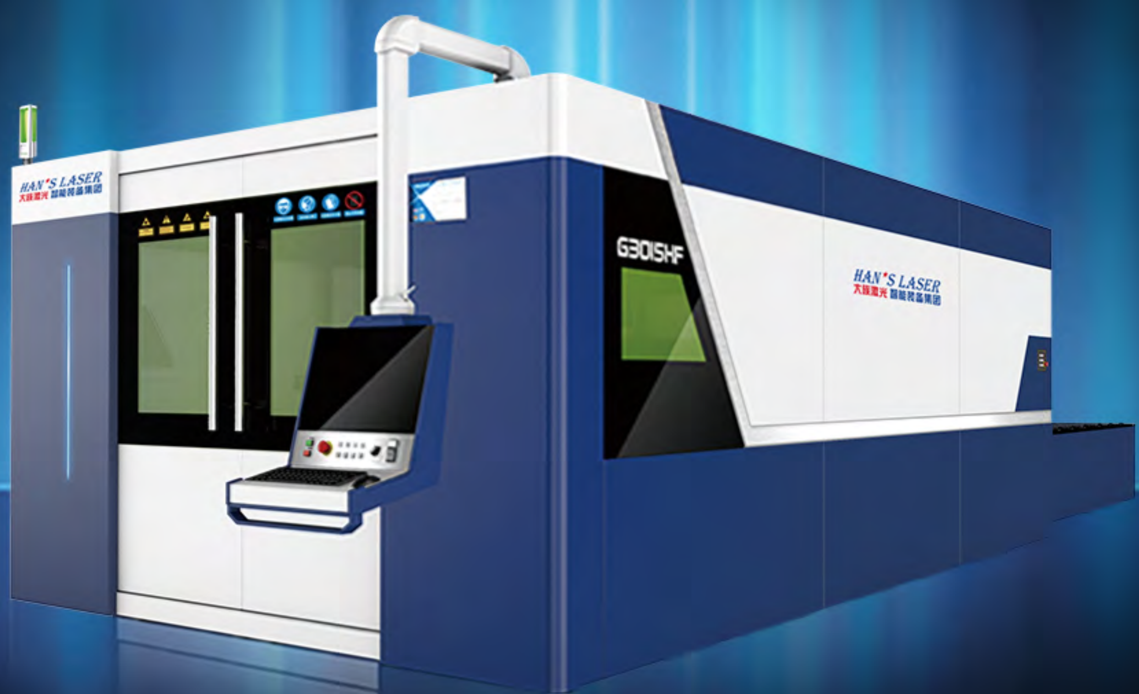
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