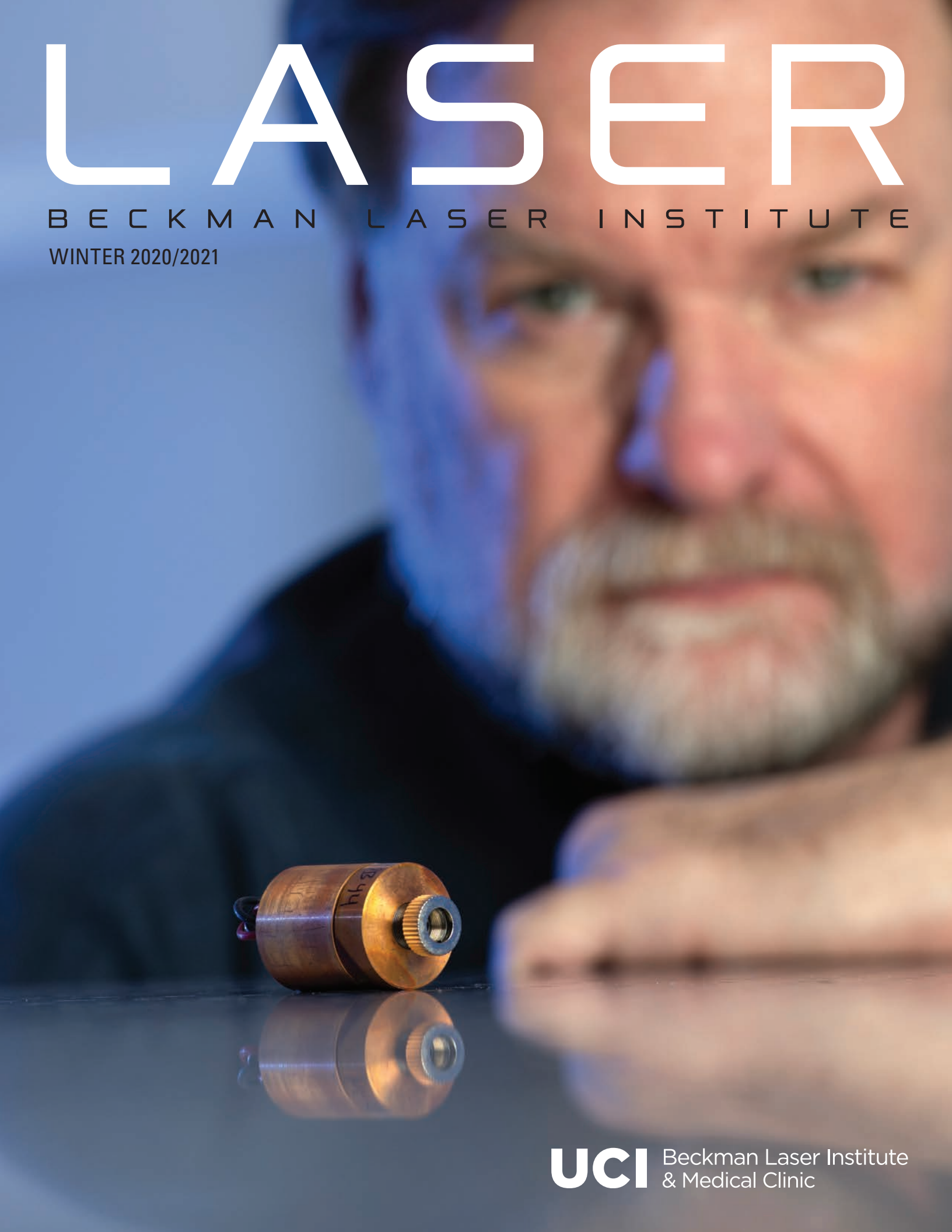
LASER

BECKMAN LASER INSTITUTE

WINTER 2020/2021



UCI Beckman Laser Institute & Medical Clinic

LASER | WINTER 2020/2021

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In this issue

Mission

Discover new optics and photonics technologies for biomedical research

Create innovative, accessible methods and devices that transform healthcare

Educate the next generation of scientists, engineers and physicians

On the Cover
Chris Barty, Ph.D., investigates using Blu-ray lasers to combat COVID-19

Photo: Steve Zylius, UCI

Kristen M. Kelly, M.D., specializes in vascular birthmarks, photo-dynamic therapy and light-based imaging

Kristen Kelly named Chair of the Department of Dermatology

On September 6, 2020, Dr. Kristen Kelly was appointed as the new chair of the Department of Dermatology. Dr. Kelly is a board-certified dermatologist with more than 25 years of experience using lasers to treat vascular birthmarks, scars and other dermatologic conditions. She is at the forefront of research in the treatment of vascular skin conditions, and contributes to the development and implementation of the latest energy based technologies, techniques and treatments in dermatology.

Help us Educate the Next Generation of Leaders

Support Ph.D. Fellowships and Leverage your Giving

Student support helps us recruit top students and provides them with the resources they need to succeed. For a limited time, the UCI Graduate Division will match new endowments in support of Ph.D. fellowships.

Establish a Ph.D. fellowship endowment and take advantage of this university match!

For more information, contact:
Gabrielle Comfort at gcomfort@uci.edu.

UCI Beckman Laser Institute & Medical Clinic
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Irvine, California 92697-1475

Photo: Austin Business Journal

IGNITED WITH EXCITEMENT FOR THE FUTURE

Twenty-three years ago, I studied as a Whitaker Research Fellow at UCI Beckman Laser Institute & Medical Clinic under the direction of Medical Director J. Stuart Nelson, M.D., Ph.D. When I returned as a candidate for the Director's position of the Institute, I was struck by the remarkable and exciting growth of the campus. Irvine's thriving medical device industry, its impact on the local healthcare economy and acceleration of scientific and engineering advances have ignited an excitement for the Institute's future.

The UCI Beckman Laser Institute & Medical Clinic is internationally recognized for improving the lives of innumerable people. **The 29 current core faculty innovators at the Institute have trained thousands of students and researchers** who are now industry and academic leaders in the United States and abroad. **The Medical Clinic has had more than 90,000 patient visits** from young children to adults who exemplify the Institute's global footprint.

Institute teams are collaborating across disciplines to discover solutions to real-world medical problems and now, **rapidly responding to the COVID-19 crisis**. A number of these projects are highlighted in this issue.

As the third director of UCI Beckman Laser Institute & Medical Clinic, I am humbled and honored to be a part of a highly skilled team of scientists, engineers and physicians who proudly uphold Dr. Arnold O. Beckman's legacy and Founder Dr. Michael Berns' pioneering vision. Together, we pursue our mission: **translate advanced laser, optical and related technologies into medicine to improve the lives of billions worldwide.**

Join us as we continue to apply our knowledge, skills and creativity to respond to the critical challenges of COVID-19 and potential future pandemics. I look forward to your partnership and wish you and your family much health and happiness.

Warm Regards,

Thomas Milner

Director, UCI Beckman Laser Institute & Medical Clinic
Professor, Surgery and Biomedical Engineering

Photo: Julie Kennedy, UCI Beall Applied Innovation

THE INSTITUTE **REVAMPED**

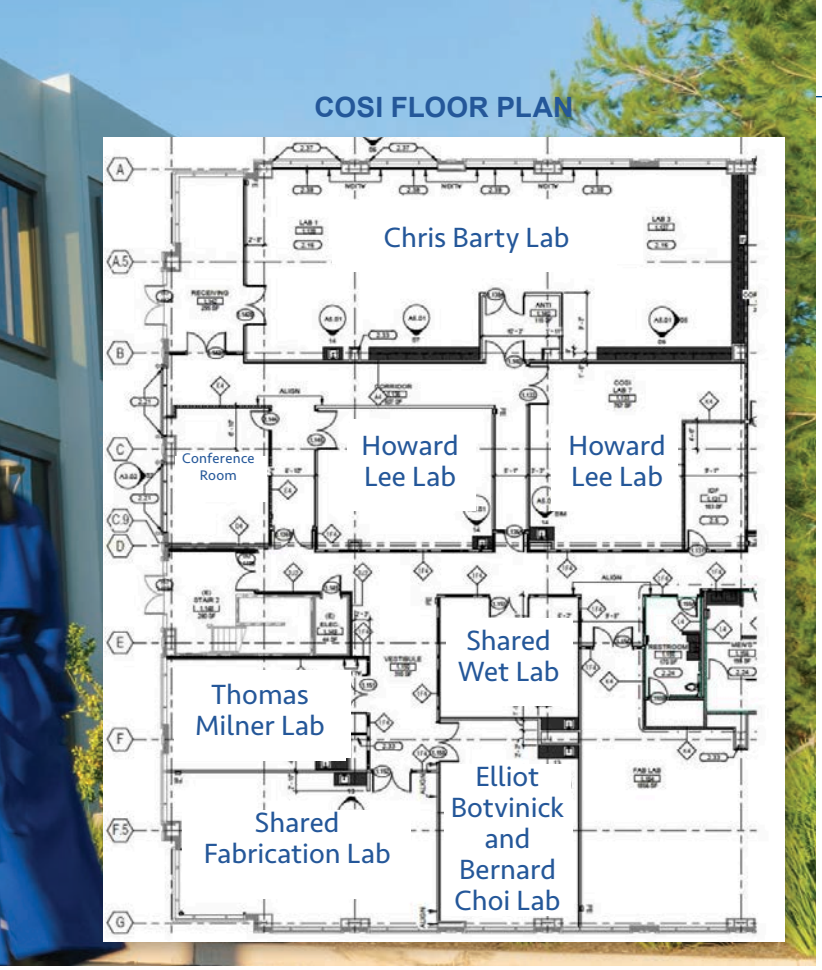
A $1.75 million gift from the Arnold and Mabel Beckman Foundation was transformative in helping to complete vital renovations to the UCI Beckman Laser Institute & Medical Clinic building's heating, ventilation and air conditioning (HVAC) systems. This ongoing project replaces and renovates the antiquated air handling capabilities of the Institute, including multiple HVAC unit replacements and modern digital environmental controls. To date, the three original HVAC units have been removed and replaced, and new environmental controls covering approximately 20 percent of the building will soon be operational. This comprehensive project will continue over the next year.

In addition, the gift from the Arnold and Mabel Beckman Foundation assisted in securing the Institute's future. UCI matched the donation from the Foundation, which led to the renovation and rental costs associated with laboratory space dedicated to the Convergence Optical Sciences Initiative (COSI). COSI labs are located in the new UCI Beall Applied Innovation building in University Research Park, adjacent to campus.

The newly established Michael and Roberta Berns LAMP laboratory

Arnold O. Beckman, Ph.D., funded half of the $5 million needed to build the Institute, while Michael W. Berns, Ph.D., raised the remaining funds through private support.

COSI FLOOR PLAN



VISIONARY COFOUNDER MICHAEL BERNS

In the early 1980s, Dr. Michael W. Berns, a professor of cell biology, hosted an open house at UCI for Orange County industry leaders to learn about his work in laser technology. Dr. Arnold O. Beckman, Founder of Beckman Instruments, Inc., attended the event, leading to Drs. Berns and Beckman forging a lasting partnership resulting in the establishment of UCI Beckman Laser Institute & Medical Clinic.

When the building opened in 1986, it housed one professor, Dr. Berns, and approximately 10 students and staff. Today, the Institute has 29 core faculty and approximately 100 individuals from nine departments in the UCI Schools of Medicine, Engineering, Physical Sciences and Biological Sciences.

BIOCHEMISTRY AND CELL CULTURE LABORATORY

The Biochemistry and Cell Culture laboratory features much-needed larger and more safely located fume hood workspaces and expanded usable wet laboratory bench workspace.

The Institute was awarded a UCI Campus Capital Improvement grant to renovate the Biochemistry and Cell Culture shared facility. The renovations enhance workflow, laboratory space availability and provide superior safety in this heavily used tissue culture and biochemistry wet laboratory.

In addition, the Institute recently received a second UCI Small Capital Improvement grant. This project will provide upgrades to heighten the security of research functions and building safety. The scope of work includes entry hall alterations, creating an improved clinic and visitor experience; a strategic addition of biometric devices for access to research laboratories and improvements to the conference room and library.

MICHAEL AND ROBERTA BERNS LASER MICROBEAM PROGRAM (LAMP) LABORATORY

In recognition of a $1 million gift from the Beckman Laser Institute, Inc. non-profit, UCI Beckman Laser Institute & Medical Clinic established the Michael and Roberta Berns LAser Microbeam Program (LAMP) Laboratory in honor of our visionary cofounder Dr. Michael Berns and his late wife, Roberta Berns. Through the generosity of Beckman Laser Institute, Inc. non-profit, the Institute was able to renovate an obsolete electron microscopy laboratory suite and purchase state-of-the-art equipment for advanced characterization, imaging and manipulation of cells.

Roberta and Michael Berns, Ph.D., with Pat Beckman. Roberta Berns, a developmental psychologist, served as a UCI Professor Emerita, where she founded and chaired the UCI Human Development Department. For many years, Roberta served on the Board of Directors of UCI Beckman Laser Institute & Medical Clinic, contributing to its success.

The Biochemistry and Cell Culture laboratory features much-needed larger and more safely located fume hood workspaces and expanded usable wet laboratory bench workspace.

TACKLING COVID-19 AND FUTURE PANDEMICS

Institute teams are focused and dedicated to discovering solutions to real-world medical problems – in areas such as airway disorders, burns and wounds, cancer, cardiovascular disease, diabetes, neurologic injury and disease, oral health, skin disease, exercise medicine, vascular malformations and trauma and critical care – and now, rapidly responding to COVID-19 and mitigating potential future pandemics.

Photo: Steve Zylius, UCI

Chris Barty, Ph.D., is developing a way to halve the wavelength of photons emitted by Blu-ray diodes, which poses minimal risk to humans.

CHRIS BARTY USES BLU-RAY DISC LASERS TO DISINFECT SURFACES

Dr. Chris Barty is adapting a **low-cost UVC light source** found in Blu-ray players that can rapidly and effectively disinfect surfaces and air. These UV light sterilizers would be inexpensive compared to current medical- and scientific-grade systems, and could broadly be deployed.

"If these sources are successful, I think you could build them into a mask and clean the air that's coming in and out of you," he said. "Or you could set these things up in the air circulation ducts of major buildings, and the airflow that goes through could be sterilized."

Dr. Barty also envisions the UV light sterilizers in hand-held wand devices or as a "light curtain" for people to walk through as they enter a room, covering them with sterilizing UV-C radiation. At this wavelength, the UV radiation will destroy viruses and other pathogens, while posing minimal risk to humans.

Elliot Botvinick, Ph.D., is investigating the relationship between the immune system and cardiac function in cases of severe coronavirus.

ELLIOT BOTVINICK AND TEAM EXAMINE THE IMPACT OF COVID-19 ON THE HEART

Drs. Elliot Botvinick, Anna Grosbert and Wendy Liu were awarded a $547,000 grant from the National Science Foundation to investigate **how COVID-19 affects the heart**. The research team will look at the interplay between the immune system and cardiac function in cases of severe coronavirus.

The virus primarily targets the lungs, however clinicians have observed that it affects the heart's ability to generate a sufficient force to pump oxygenated blood throughout the body. This may be due to an insufficient availability of oxygen for the heart muscle, or hypoxia, and an overstimulated immune system. In this study, the researchers are developing a novel immuno-heart in vitro platform, to show the relationship between cardiac biomechanics and the combination of hypoxia and an overactive immune system.

Article adapted from "Researchers to Examine COVID-19 Impact on Heart Function" by Lori Brandt, UCI Samueli School of Engineering

Image: UCI

The 'bridge' devices are easily made to serve as stopgaps when medical-grade ventilators are not in full supply.

CONSORTIUM LAUNCHES TO PREVENT, DIAGNOSE AND TREAT COVID-19 PATIENTS

Drs. Thomas Milner, Brian Wong and Govind Rajan established the **Bridge Ventilator Consortium (BVC)** for individuals, universities and private enterprises around the country to support the development, testing and translation of methods and devices to prevent, diagnose and treat COVID-19 patients.

Two quick-to-manufacture, inexpensive bridge ventilators spun out of the BVC, which can be used when intensive care units (ICU) are overwhelmed and no standard ICU ventilators are available for patients undergoing respiratory failure.

With a ventilator shortage no longer of high concern, the group of industry, academic and government leaders are now focused on noninvasive ventilation, microwave inactivation, light-based therapies and other technology-based solutions to address COVID-19-related problems.

Article adapted from "UCI team initiates effort to build 'bridge' ventilators" by Tom Vasich, UCI

The ventilator uses a modified CPAP device.

REPURPOSED CPAP MACHINES HELP PATIENTS BREATHE

Drs. Elliot Botvinick and Bernard Choi are creating a ventilator that repurposes a common household device, a **Continuous Positive Airway Pressure (CPAP) machine**. This machine typically used for the treatment of sleep apnea allows patients to control their own breathing with less lung trauma.

"There is an abundance of available CPAP devices because users typically upgrade their device every few years. These abandoned devices can be repurposed for medical ventilation − with proper engineering and medical guidance," said Dr. Botvinick. Dr. Matthew Brenner proposed the idea, while Drs. Botvinick and Choi are leading design efforts. "CPAP devices provide pressure to keep airways open. They can be modified to provide increased pressure, and with further design enhancements proposed by Professors Botvinick and Choi, can provide intermittent positive pressure breaths," said Dr. Brenner.

Article adapted from "UCI Engineers Collaborate to Attack Virus" by Anna Lynn Sptizer and Lori Brandt, UCI Samueli School of Engineering

OPTICAL SCREENING SYSTEM DETECTS THOSE INFECTED WITH SARS-COV-2

Drs. Thomas Milner, Matthew Brenner and Robert Brown are developing an **optical screening system** that allows rapid and low-cost detection of individuals infected with SARS-CoV-2. The goal of this project is to develop one solution that incorporates an intelligent mask that mitigates against individual transmission, while simultaneously allowing for widespread, rapid, low-cost, repeatable and accurate SARS-CoV-2 screening.

VITAL INVESTIGATIONS CONTINUE TO COMBAT COVID-19

Other UCI Beckman Laser Institute & Medical Clinic researchers are investigating long-term, **light-based diagnostic, sterilization and treatment strategies**, including therapeutic approaches that use photo-active agents that target COVID-19 in the throat and low-cost diagnostic imaging that can detect micro-clotting in COVID-19 ICU patients.

To learn more about how Institute researchers are navigating this ever-changing pandemic, please visit: www.bli.uci.edu/news.

To donate in support of the Institute's efforts to mitigate COVID-19 and future pandemics, please visit: www.connect.uci.edu/BLIpandemic.

"I am so grateful for the opportunity I had to be part of the [ACES] program. It has definitely prepared me and encouraged me to pursue a Ph.D. in electrical engineering. I was accepted into the UCI Electrical Engineering and Computer Science program. This was a dream come true for me. Thanks to the program, my mentors and other program faculty and staff, my dreams are now a reality."

—Breyah Matthews
UC-HBCU program participant '17
UCI graduate student

ACES SUMMER PROGRAM GOES VIRTUAL

HIGH-ACHIEVING, UNDERREPRESENTED STUDENTS GET A GLIMPSE OF GRADUATE SCHOOL

This past summer, the Institute hosted 10 students for the virtual Access to Careers in Engineering and Sciences (ACES) program. The UC Office of the President-supported Historically Black Colleges and Universities (HBCU) partner program funds this summer training initiative. The program introduces high-achieving, underrepresented undergraduate students to the possibilities of graduate education and the breadth of UCI graduate programs in the fields of biomedical engineering, biophotonics and related Science, Technology, Engineering and Math (STEM) disciplines.

ACES has resulted in the acceptance of five talented Black students to University of California campuses in STEM Ph.D. programs. Breyah Matthews joined the UCI Advanced Power and Electricity program in the Department of Electrical Engineering and is entering her third year of graduate study. Alexius Lampkin was accepted at UC Davis, but chose to attend University of Wisconsin as a Ph.D. student in Chemistry. In addition, Chris Johnson, Lauryn Alexander and Jakari Harris were accepted into Ph.D. programs at UCI. Chris is in his second year in the UCI Department of Biomedical Engineering. Lauryn matriculated at West Virginia University to pursue a Ph.D. in Forensic Sciences and Jakari Harris enrolled in a joint Ph.D. program in Biomedical Engineering at Georgia Tech/Emory University.

NEW FACULTY INNOVATORS

ANAND GANESAN, M.D., PH.D.

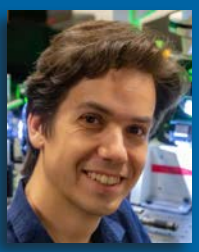
Professor, Dermatology, Biological Chemistry

Dr. Ganesan's work utilizes RNAi-based functional genomics to define novel pathways that regulate melanin production and melanoma chemoresistance. His research focuses on understanding how melanocytes respond to environmental cues (UV irradiation, inflammation) in order to maintain normal homeostasis and determining how homeostasis is disrupted in disease (melanoma, vitiligo).

HOWARD LEE, PH.D.

Associate Professor, Physics and Astronomy

Dr. Lee's research focuses on using emerging nanophotonic platforms and "meta"-optical fibers for advancing optical imaging, sensing and medical applications. This includes the development of advanced in-fiber imaging endoscopy or laser surgery element, tip-enhanced Raman spectroscopy for molecule detection and biosensing, novel optical fiber laser source/nano-laser and a new optical cooling/trapping platform.



DARYL PREECE, PH.D.

Assistant Professor, Biomedical Engineering

A donation from Beckman Laser Institute, Inc. non-profit supported the renovation of the former Histology Lab, as well as the recruitment of Dr. Preece. Dr. Preece is an expert in biophotonics, using light to study and manipulate cells and organelles. His research spans from fundamental optics to translational biophotonics. Major areas of activity include holographic optical tweezers, singular optics, laser cell surgery and laser-induced shockwaves, neuronal repair and function and biomechanics. His work focuses on the development of new neurophotonic technologies to better understand circuit level neural interactions and the utilization of complex light for applications in bio and nanotechnology.

ROBERT WILSON, PH.D.

Assistant Professor In-Residence, Medicine

Dr. Wilson's research interest is the development of mathematical approaches and clinical translation of experimental techniques for quantifying light transport in biological tissue for diagnostic and monitoring applications. His research goals are to create new experimental and computational tissue-optics technology and to incorporate this technology into interdisciplinary pre-clinical and clinical research in areas, including neuroscience, neuro-critical care, cancer detection and treatment, cardiovascular health and sports science.

LIANGZHONG (SHAWN) XIANG, PH.D.

Associate Professor, Biomedical Engineering, Radiology

Dr. Xiang's Theranostics with Radiation-Induced Ultrasound Emission (TRUE) lab's research is focused on biomedical imaging and image-guided cancer treatment. He and his team were the first to report x-ray induced acoustic computed tomography, fast proton-induced acoustic imaging and electroacoustic tomography.

Matthew Brenner, M.D., and Sari Mahon, Ph.D.

SURVIVING CHEMICAL THREATS

NIH MULTI-SITE "ADVANCING NOVEL CYANIDE COUNTERMEASURES" CENTER GRANT

Cyanide poisoning poses a major chemical threat, whether due to terrorism, structure fires or industrial accidents. Developing new cyanide antidotes is critical to survival and a designated National Institutes of Health (NIH) priority. The NIH Countermeasures Against Chemical Threats (CounterACT) program supports basic and translational research aimed at the development of improved therapeutic medical countermeasures against chemical threat agents and facilitates studies through drug development and regulatory processes.

Dr. Matthew Brenner's research is on developing effective rescue countermeasures for toxic inhaled chemical threat agents. In 2019, Dr. Brenner and his collaborators were awarded a five-year "Center of Excellence" grant from the NIH National Institute of Neurological Disorders and Stroke titled, "Advancing Novel Cyanide Countermeasures." This multi-site center grant, which provides more than $3.2 million in annual funding to the combined sites, is administered through Harvard/Brigham and Women's Hospital/Partners in Boston, with multiple, highly collaborative projects spanning six institutions, including Harvard, Purdue, University of Utah, University of Colorado, UC San Diego and UCI.

The University of Colorado and UCI Beckman Laser Institute & Medical Clinic comprise the "Animal Modeling, Photonics, and Efficacy Evaluation Core," which makes use of novel Institute developed photonics-based diagnostic technologies. The teams will use advanced diagnostics and imaging to monitor real-time physiological consequences of cyanide-induced injury and responses to new antidote therapies.

Dr. Brenner and his team will utilize the Institute's Animal Operating Room and Research Facilities. Multiple Institute technologies, including Diffuse Optical Spectroscopy (DOS), developed in former Institute Director Dr. Bruce Tromberg's laboratory, and Continuous Wave Near Infrared Spectroscopy (CWNIRS) will be used to assess the effects of cyanide poisoning. These technologies allow real-time monitoring of tissue oxygenation and can follow the chemical asphyxiation of cells caused by cyanide by revealing cytochrome c oxidase redox states. In addition, real-time micro-sensors for continuous tissue lactate monitoring, developed by Dr. Elliot Botvinick, will measure metabolic poison exposure consequences.

The Institute investigations will support projects and explorations at each of the other university sites and the findings will influence pharmaceutical development and metabolomics profiling for mechanistic understanding of cyanide poisoning. This academic partnership plays a significant role in accelerating the development of countermeasures in the face of new and emerging chemical threats.

FOUNDER'S COLUMN

SHINING BRIGHTER

We exist in confusing and troubling times. Despite the uncertainty of the COVID-19 pandemic, a contentious presidential election and impending climate catastrophe, there is a bright light that continues to shine through the haze of uncertainty—UCI Beckman Laser Institute & Medical Clinic.

The future shines brighter. This year, we secured another three years of funding from the Air Force Office of Scientific Research (AFOSR). First awarded in 1986, the grant is one of the longest continually funded grants in UCI history, serving as a core program of the Institute. This recent more than $8 million of funding supports eight different faculty research projects focused on developing new approaches and technologies to aid in the trauma associated with combat casualties, as well as civilian trauma. The renewal provides a level of financial stability at a critical junction in the Institute's history, while endorsing the organization's commitment to our success.

Another shining example is the selection of Dr. Thomas Milner, as the third director of UCI Beckman Laser Institute & Medical Clinic. Dr. Milner succeeds the distinguished Dr. Bruce Tromberg who is currently the Director of the National Institute of Biomedical Imaging and Bioengineering. Dr. Milner joins us from the University of Texas, Austin where he served for more than 20 years as a Distinguished Professor of Biomedical Engineering. Dr. Milner has contributed greatly to the development of innovative therapeutic and diagnostic optical technologies in the medical field. Having served as a postdoctoral student at UCI Beckman Laser Institute & Medical Clinic, working under the guidance of Medical Director Dr. Stuart Nelson, we are enthusiastic about Dr. Milner's return to the Institute, where he started his career.

Institute researchers are laser-focused on applying their vast years of experience in optics and photonics to assist in the diagnostics and treatment of COVID-19 patients. These efforts are featured in this issue. Galvanizing Institute expertise to aid in this international crisis speaks volumes of the Institute programs, responding quickly to tackle this major medical problem.

UCI Beckman Laser Institute & Medical Clinic secured funding in support of numerous building renovations that greatly improve the quality and capabilities of key laboratories. The LAser Microbeam Program (LAMP) Laboratory was established in recognition of a generous $1 million donation from Beckman Laser Institute, Inc. non-profit. In addition, the Arnold and Mabel Beckman Foundation provided a gift to update the building's HVAC system. Lastly, the Institute was fortunate to secure two UCI Capital Improvement grants to remodel the Biochemistry and Cell Culture facility, as well as provide much-needed building and security upgrades.

This is a new and exciting period for UCI Beckman Laser Institute & Medical Clinic. I am extremely proud of our accomplishments and optimistic about our brilliant future. The photons of the Institute continue to shine brightly.

Shine Brighter,

Michael W. Berns
Cofounder, UCI Beckman Laser Institute & Medical Clinic
Arnold and Mabel Beckman Chair in Laser Biomedicine
Distinguished Professor, Surgery, Biomedical Engineering

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