LASER
BECKMAN LASER INSTITUTE

IN THE NEWS

SUMMER 2015

Antidotes for Mass Casualty Chemical Threats

The primary objective of the National Institutes of Health (NIH) CounterACT program is to develop medical countermeasures for mass casualty chemical threat agents. A 5-year grant has recently been awarded to Gerry Boss, M.D., Professor of Medicine at UC San Diego, for "Development of the vitamin B12 analog cobinamide as a hydrogen sulfide antidote." The grant includes a subcontract to Beckman Laser Institute (BLI) physician researcher, Dr. Matthew Brenner, UCI Professor of Pulmonary and Critical Care Medicine, to test antidotes for hydrogen sulfide given both by intramuscular delivery and inhaled delivery. Dr. Brenner's group has been working with Dr. Boss for the last 8 years to develop the cyanide antidote, cobinamide. They are now expanding that work to develop and test cobinamide for use as a hydrogen sulfide antidote.

Potential cobinamide auto-injector.

Hydrogen sulfide is a highly toxic gas and is the second leading cause of inhalation fatalities after carbon monoxide. Hydrogen sulfide is easy to generate, thus making it a popular suicide agent and attractive to terrorists as a weapon of mass destruction. It is also a major hazard in the oil and gas industry. Recurrent or prolonged exposure to hydrogen sulfide leads to neurological abnormalities and even a single exposure can have neurologic aftereffects. Unfortunately, no therapy exists for sulfide poisoning. Although experimental data indicate vitamin B12 and sodium nitrite may have a beneficial effect, they must be administered in high doses before or immediately after sulfide exposure. Through support from a previous exploratory grant, Drs. Brenner and Boss have found that the vitamin B12 analog cobinamide is a potent sulfide antidote in cells, flies, mice and rabbits, and that

(Antidotes continued on p. 3)

Newsbriefs

MI, Inc., Moves Out of Photonic Incubator

Modulated Imaging, Inc. (MI), is a prime example of how the Photonic Incubator at the Beckman Laser Institute (BLI) can take a research project and turn it into a rapidly growing commercial business. MI was founded in 2005 by then Ph.D. candidate David Cuccia, along with Frederic Bevilacqua, Ph.D., Joon You, Ph.D., and BLI faculty Bruce Tromberg, Ph.D., and Anthony Durkin, Ph.D. After completing his doctoral studies in the fall of 2006, Dr. Cuccia began working full time to get MI off the ground. Key to the early success of MI was the availability of the Photonic Incubator which provided office space and laboratory facilities and a rich network of both technical and business mentors who helped guide the company through its commercialization efforts.

Ox-Imager RS

The team at MI has been working hard to bring Spatial Frequency Domain Imaging (SFDI), a technology originally developed at BLI, to the market. MI's recently launched Ox-Imager RS is the first turnkey, commercially available instrument to employ SFDI. Ox-Imager RS uses structured light to measure multiple tissue parameters that relate to tissue health. The Ox-Imager RS is sold to biomedical researchers who are studying a wide range of applications, including burns and chronic wounds, and is also used by cosmetics companies to study the effects of various topical products on skin. A medical version of the Ox-Imager is expected to receive FDA clearance in early 2016.

The MI team includes: CEO/CTO David Cuccia, Ph.D. (UCI/BLI), Director of Finance and Administration Fred Ayers, M.S. (UCI/BLI), Director of R&D Amaan Mazhar, Ph.D. (UCI/BLI), Lead Programmer Pierre Khoury, M.S., and Manufacturing Engineer Chris Campbell, formerly of BLI. The company

(Newsbriefs continued on p. 2)

Reflection

by Michael W. Berns, Ph.D.
Arnold and Mabel Beckman Professor
Co-Founder, Beckman Laser Institute

We all have dark days. I've had quite a few the past several months: a period of massive introspection and thoughts about the future. I must say that many of my BLI and UCSD colleagues, as well as other friends, have been enormously supportive. This period has given me a chance to take stock of the Institute, its people, and the scientific and medical value of what we do.

Yes, directions have been and are changing; projects have ended, new projects have begun, and old projects that seem to have gone on forever, continue as if they'll never end. All of this is the normal course of science. While we sometimes get bored, overloaded, "under-loaded," and get the itch to move on to something else, one thing that has struck me is that the excitement and vitality still remains. After almost 35 years, the BLI continues to forge ahead with new discoveries, many of which have the potential to benefit the health and well-being of our species. As the Founder of the BLI with Dr. Beckman back in 1982 (before the building was even conceived), I am proud that new ideas and experiments continue to flourish, and patients are treated in our clinic for conditions that could only be mitigated by "light." ■

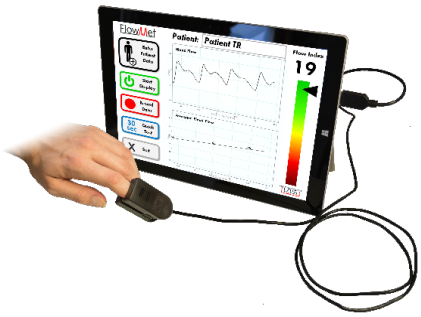
Newsbriefs *(cont'd from p. 1)*

has recently recruited two medical device veterans, COO Richard Oberreiter and VP of Engineering Bruce Sargeant, to lead the company through its expansion and evolution into a medical device-focused operation. In addition to the in-house team, MI continues to tap BLI students, faculty, and alumni for their expertise. Currently, Drs. Anthony Durkin and Matthew Brenner are collaborating with MI on SBIR grant supported research from the National Institutes of Health, and UCI/BLI alumnus Tyler Rice, Ph.D., has contributed important modeling work for algorithms. Along with the staff expansion, MI has elected its board of directors: BLI Director Bruce Tromberg, Randy Lunn of Catalina Ventures, and Andrew Campbell, a retired healthcare executive and private equity investor.

Before the end of 2015, MI will be adding business development and sales positions to accelerate its already record sales of the Ox-Imager RS and its forthcoming medical device version of the Ox-Imager. To accommodate the company's expansion, MI has consolidated its San Juan Capistrano offices and BLI lab at a new 5,877 sq. ft. facility in Irvine. The new facility has a dedicated lab, manufacturing room, offices and collaborative working areas.

LAS Moves into Photonic Incubator

Laser Associated Sciences (LAS) has developed non-invasive, light-based technology to measure microvascular blood flow. Its first product, the FlowMet, is a clip-on device with a form-factor similar to a pulse oximeter which is capable of measuring peripheral blood flow continuously and in real time. LAS is currently focused on using FlowMet



Second-generation FlowMet system

intra-operatively during peripheral revascularization procedures (angioplasty, atherectomy, vascular bypass) to inform clinicians when/if normative blood flow has been restored to the extremities. Future development will entail the development of home-based blood flow monitors for use in post-operative monitoring to alert clinicians to necessary re-intervention and prevent unnecessary follow-ups.

LAS has a strong connection to BLI: it was founded by BLI graduates Sean White, Bruce Yang, and Tyler Rice. Sean White and Bruce Yang graduated from the laboratory of Bernard Choi, where Sean is currently a postdoctoral scholar and Bruce is a Specialist. Tyler Rice completed his graduate degree under the direction of BLI Director Bruce Tromberg. BLI purchased the very first second-generation FlowMet system to study subtle alterations in peripheral blood flow resulting from various physiological interventions. LAS will begin incubating at BLI to further their business and technology development in August 2015.

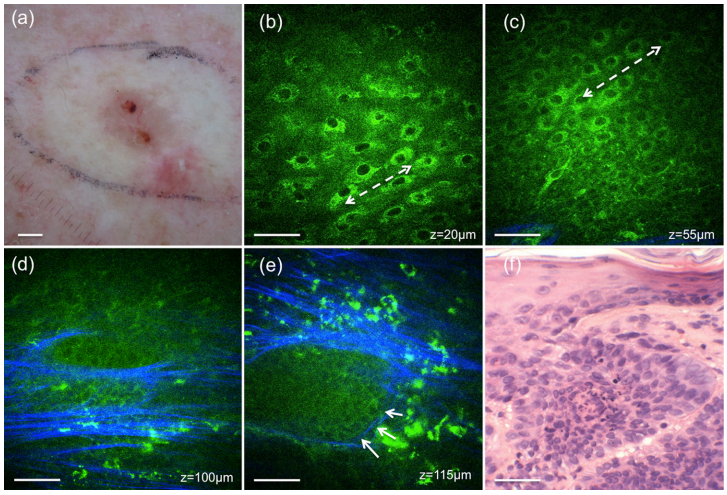
Radoptics Joins the Photonic Incubator

Radoptics, a start-up company interested in development and commercialization of biologically-derived optical platforms, has joined the Photonic Incubator. These platforms include mammalian cells, such as erythrocytes (red blood cells), that can be doped with various near-infrared materials and serve as photo-theranostic agents with ability for combined optical imaging and therapy of various diseases including different cancer types as well as non-cancerous dermatological abnormalities. Radoptics was founded by Bahman Anvari, Ph.D., who was a postdoctoral research fellow at BLI from 1993-1995. Dr. Anvari is currently Professor of Bioengineering at UC Riverside.

Multiphoton Microscopy of Basal Cell Carcinoma

Basal cell carcinoma (BCC) is a form of skin cancer originating from the basal cell layer of the epidermis and associated follicular structures. It is the most common human cancer, accounting for 25% of all cancer cases and 75% of skin malignant neoplasms diagnosed in the United States. Basal cell carcinomas are diagnosed primarily by clinical evaluation. Furthermore, an increasing number of clinicians are being trained in the art of dermoscopy to aid in the diagnosis of early tumors. The definitive diagnosis has always been provided by a skin biopsy followed by sample preparation and histopathologic examination.

Advances in optical imaging and spectroscopy technologies raise the possibility of performing rapid and noninvasive light-based histopathologic examination, a pain-free process that would be appreciated by patients and reduce the time from consultation to treatment. Therefore, technologies, such as multiphoton microscopy (MPM), have been investigated for their applicability for diagnosis of skin cancer, including BCC. The microscopy laser-scanning technique of MPM has the ability to produce submicron resolution images. In a study published online April 24, 2015, in the *Journal of the American Medical Association Dermatology* ("In vivo multiphoton microscopy of basal cell carcinoma" by BLI researchers M. Balu, C. B. Zachary, R. M. Harris, T. B. Krasieva, K. Konig, B. J. Tromberg and K. M. Kelly), the authors assessed the ability of MPM to visualize the BCC tumor nests and their cellular structure. The work was facilitated by using a recently developed clinical multiphoton tomograph (MPTflex; JenLab GmbH). It is a portable instrument with an articulated arm which allows imaging lesions on different parts of the body rather than being limited to lesions on the extremities.



Nodular and superficial basal cell carcinoma (BCC). *(a) Clinical image (DermLite FOTO, Dermlite Inc.). Scale bar is 2 mm. (b) MPM image of the stratum granulosum showing elongated tumor cells aligned in one direction (arrow). (c) MPM image of the lower epidermis showing tumor cells aligned in one direction (arrow). (d) MPM image showing parallel collagen fibers (blue) on top of tumor. (e) MPM image showing parallel collagen fibers surrounding a BCC tumor nest. Arrows show palisading in the peripheral cell layer. (f) Histologic section of the lesion. Scale bar is 40µm.*

The study, conducted on 9 patients prior to biopsy, showed that MPM is capable of imaging in vivo tumor nests in BCC lesions of superficial and nodular types along with other features that may be specific to BCC. The MPM imaging was able to visualize the cellular structure inside the tumor nests of BCC lesions that included superficial components. These results provide the groundwork for a future study with a larger number of patients that would assess MPM imaging sensitivity and specificity for in vivo noninvasive BCC diagnosis. ■

Antidotes *(cont'd from p. 1)*

it appears to be effective if given after sulfide exposure. The Brenner lab makes use of BLI-developed technologies, including diffuse optical spectroscopy (DOS), to follow the physiological effects of hydrogen sulfide poisoning and to monitor recovery after antidote administration.

Cobinamide is very water soluble and stable in solution which, combined with its high potency, allows it to be administered in a small volume from a pre-filled syringe. The Brenner and Boss groups have developed a cobinamide formulation that is absorbed rapidly after intramuscular injection. This cobinamide form, referred to as nitrocobinamide, could be administered quickly by intramuscular injection via an autoinjector in a mass casualty setting. It could also be given by inhalation using recently-developed high-flow nebulizers; this may be especially beneficial for sulfide poisoning because sulfide causes severe pulmonary toxicity which may be moderated by an inhaled drug. Moreover, inhalational delivery could be useful prophylactically by first responders, particularly in industrial settings where co-workers coming to rescue a sulfide gas-exposed colleague become poisoned themselves.

As part of this work, an additional subcontract has been awarded to Dr. Chen Tsai, UCI Professor of Electrical Engineering and Computer Science, who will continue to simultaneously develop a unique and proprietary high throughput ultrasonic nebulizer for use with the drug.

Successful outcome of the work supported by this new grant may lead to the development of cobinamide as a mass casualty treatment for hydrogen sulfide exposure.

New Arrivals

Tiancheng Huo

Tiancheng Huo, Ph.D., is a Postdoctoral Fellow from the Department of Physics, Tsinghua University, Beijing, China. He will be working on optical coherence tomography in Dr. Zhongping Chen's lab.

Betul Ilhan

Betul Ilhan, D.D.S., Ph.D., is a Visiting Associate Professor from the Department of Oral Medicine and Diagnosis, University of Izmir, Turkey. She will be working in the lab of Dr. Petra Wilder-Smith for one year to develop new salivary biomarkers to identify the risk of developing oral cancer.

Jinmei Liu

Jinmei Liu, Ph.D., is a Visiting Professor from the Department of Physics, East China Normal University, Shanghai, China. She is working on optical imaging in the lab of Dr. Zhongping Chen.

Ilyong Park

Ilyong Park, Ph.D., is a Visiting Scholar from BLI Korea and the Department of Biomedical Engineering, College of Medicine, Dankook University, Cheonan, South Korea. He will be at BLI for one year working with Drs. Bruce Tromberg and Anthony Durkin.

Hampton University Students

Two undergraduate students from Hampton University, located in Hampton, Virginia, received grants for summer study at BLI. They are the first students to come to BLI as a result of a desire between BLI Director Bruce Tromberg and Dr. Ray Samuel, Assistant Dean for Research in the School of Engineering and Technology at Hampton University, to create a long-term program to bring students from Hampton, a historically black university, to experience engineering and biophotonics research and encourage them to pursue graduate studies and careers in biophotonics, engineering, and other STEM area studies at UCI.

Katiso Mabulu

Under the mentorship of Drs. Bernard Choi and Bruce Tromberg, Katiso Mabulu studied laser imaging to understand the hemodynamics of the vasculature in the brain while under cardiac arrest. Under the mentorship of Dr. Matthew Brenner, Breyah Matthews researched designing and creating an apparatus to quantify an antidote to hydrogen sulfide gas exposure. ▪

Breyah Matthews

Innovator of the Year

Elliot Botvinick, Associate Professor of Biomedical Engineering, was selected as the Innovator of the Year by The Henry Samueli School of Engineering. This award is presented to an individual or team who best demonstrates innovation in the development of a product or technology. The award recognizes achievements in which the innovation has successfully translated the research emanating from the school's laboratories into new products and technologies that can be used by the public at large. Dr. Botvinick's main research fields are optical tweezers and biomechanics and diabetes research, specifically pancreatic islets immuno-isolation and transplantation (in collaboration with Associate Professor of Surgery Jonathan Lakey). The award ceremony was held on June 10, 2015. ▪

Elliot Botvinick (left) receives Innovator of the Year award from The Henry Samueli School of Engineering Dean Gregory Washington.

BLI Newsletter Staff
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Recent Publications

"Intraoperative, real-time monitoring of blood flow dynamics associated with laser surgery of port wine stain birthmarks" by B. Yang, O. Yang, J. Guzman, P. Nguyen, C. Crouzet, K. E. Osann, K. M. Kelly, J. S. Nelson and B. Choi in *Lasers in Surgery and Medicine* 47: 469-475, 2015 (Cover Article).

"Measurement of ciliary beat frequency using Doppler optical coherence tomography" by B. T. Lemieux, J. J. Chen, J. Jing, Z. Chen and B. J. F. Wong in *International Forum of Allergy & Rhinology* XX: 1-7, 2015.

"In vivo microvascular network imaging of the human retina combined with an automatic three-dimensional segmentation method" by S. Huang, Z. Piao, J. Zhu, F. Lu and Z. Chen in *Journal of Biomedical Optics* 20: 076003, 2015.

"Imaging and characterizing shear wave and shear modulus under orthogonal acoustic radiation force excitation using OCT Doppler variance method" by J. Zhu, Y. Qu, T. Ma, R. Li, Y. Du, S. Huang, K. K. Shung, Q. Zhou and Z. Chen in *Optics Letters* 40: 2099-2102, 2015.

"Evaluating visual perception for assessing reconstructed flap health" by A. Ponticorvo, E. Taydas, A. Mazhar, J. Rimler, H.-S. Kim, T. Scholz, C. L. Ellstrom, J. Tong, G. R. D. Evans, D. J. Cuccia and A. J. Durkin in *Journal of Surgical Research* 197: 210-217, 2015.

"In vivo measurements of cutaneous melanin across spatial scales: using multiphoton microscopy and spatial frequency domain spectroscopy" by R. B. Saager, M. Balu, V. Crosignani, A. Sharif, A. J. Durkin, K. M. Kelly and B. J. Tromberg in *Journal of Biomedical Optics* 20: 66005, 2015.

"Utility of spatial frequency domain imaging (SFDI) and laser speckle imaging (LSI) to non-invasively diagnose burn depth in a porcine model" by D. M. Burmeister, A. Ponticorvo, B. Yang, S. C. Becerra, B. Choi, A. J. Durkin and R. J. Christy in *Burns* pii: S0305-4179(15)00061-3, 2015.

"Fiber-based laser speckle imaging for the detection of pulsatile flow" by C. Regan, B. Y. Yang, K. C. Mayzel, J. C. Ramirez-San-Juan, P. Wilder-Smith and B. Choi in *Lasers in Surgery and Medicine* 47: 520-525, 2015.

Honors and Awards

Ram Ramalingam, Ph.D.

Ram Ramalingam

Dr. Ram Ramalingam, CEO of OCT Medical Imaging Inc. (OCTMI), a privately held medical device spin-off company from the Photonic Incubator at the Beckman Laser Institute (BLI), has received a fast-track Small Business Innovation Research (SBIR) grant from the National Heart Lung Blood Institute (NHLBI) for "Clinical evaluation and development of a diagnostic multi-modal intravascular imaging system." This SBIR grant with potential support for two and a half years will be led by Dr. Ram Ramalingam, co-founder of OCTMI, and will involve clinicians from Columbia University Medical School (CUMS) and University of California Irvine Medical School (UCIMS). This milestone-based grant will be released in two phases: the first phase involves preclinical and animal studies, and the second phase involves optimization and clinical studies at CUMS and UCIMS. The grant proposes to develop a cost-effective clinical multimodal intravascular imaging system that combines two FDA approved intravascular imaging technologies, ultra high-resolution optical coherence tomography (OCT) and Intravascular Ultrasound (IVUS), into a single catheter. The integrated IVUS/OCT technology was developed in the lab of Prof. Zhongping Chen (co-founder of OCTMI) at BLI and licensed by OCTMI.

This combined multimodal vascular imaging system will permit cross-sectional, simultaneous real-time visualization deep into the vascular artery wall at a high resolution which is not possible with any of these technologies alone. This hybrid sensor-based catheter combines the high spatial resolution of OCT and the broad imaging depth of IVUS and could potentially replace a separate catheter for each modality. Interventionists at their own discretion could now perform either IVUS-OCT multimodal imaging or IVUS or OCT alone imaging during percutaneous coronary intervention (PCI) procedures. Most importantly, the hybrid-imaging sensor would not only reduce the entire procedure time but also could reduce hospital costs up to 50% with better outcomes and could enhance patient safety. These studies will broaden the use of IVUS-OCT platform technology for intravascular imaging to detect vulnerable plaques during PCI interventions as well as utility in vessel sizing, stent sizing and post stent follow-up and potential applications in perivascular and carotid artery disease.

Rachel Gurlin, B.S.

Rachel Gurlin

Biomedical Engineering graduate student Rachel Gurlin received a grant from the Whitaker International Summer Program which provides funding for U.S. bioengineers and biomedical engineers to continue their existing Master's or Ph.D. work abroad. She went to the University of Groningen, The Netherlands, for 8 weeks to continue work she is doing in Dr. Elliot Botvinick's lab. Her work involves the development of a bioartificial pancreas device as a potential therapeutic approach to Type I diabetes. The device, composed of functional pancreatic islet cells encapsulated into alginate beads, will potentially replace pancreatic islet cells destroyed by the immune system. Rachel analyzed the implanted devices for inflammation, wound healing, and stability of the alginate beads which protect the cells from immune destruction in the host.

Beckman Laser Institute Director Receives Award from the OSA

Bruce Tromberg

The Optical Society (OSA) announced that Beckman Laser Institute Director Bruce Tromberg, Ph.D., is the recipient of the Michael S. Feld Biophotonics Award. One of 15 prestigious awards bestowed by the OSA in 2015, the Michael S. Feld Biophotonics Award recognizes individuals for their innovative and influential contributions to the field of biophotonics, regardless of their career stage. Dr. Tromberg "is being recognized for serving as an advocate for and a leader of the biophotonics community as well as for pioneering the development and clinical application of spatially and temporally modulated light imaging."

Dr. Tromberg is the Director of the Beckman Laser Institute and Medical Clinic (BLI) at the University of California, Irvine (UCI) and principal investigator of the Laser Microbeam and Medical Program (LAMMP), an NIH National Biomedical Technology Research Center. He is a professor in the departments of biomedical engineering and surgery, co-leads the Onco-imaging and Biotechnology Program in UCI's Chao Family Comprehensive Cancer Center, and has been a member of the BLI faculty since 1990. Dr. Tromberg's research is focused on the development of quantitative, broadband Biophotonics technologies for characterizing and imaging tissue structure, function and composition across spatial scales. He has pioneered model-based methods that utilize spatially and temporally modulated light sources for diffuse optical spectroscopy and imaging, non-linear optical microscopy, and multi-modality imaging. He has applied these technologies to the discovery and validation of quantitative imaging endpoints for detecting disease and improving therapeutic outcome for patients.

Founded in 1916, OSA is the leading professional organization for scientists, engineers, students and entrepreneurs who fuel discoveries, shape real-life applications and accelerate achievements in the science of light. Elizabeth Rogan, CEO of the OSA, remarked, "The recipients have demonstrated an expertise and leadership in their chosen field and have made significant contributions to the understanding of optics and photonics. OSA congratulates them on their outstanding achievements." ■

Congratulations to UROP and SURP Recipients

Each academic year, the Undergraduate Research Opportunities Program (UROP) awards fellowships to support noteworthy research during the academic year and SURP awards for the summer. The following undergraduate students working in the labs of BLI faculty were named as UROP Fellows for 2014-2015 and SURP Fellows for 2015.

Mentor: Dr. Elliot Botvinick
Thi Tran, "Elucidating the role of matrix stiffness in promoting tumor progression" (UROP).

Janelle Halog, "Analyzing force-extension curves to study biophysical differences in the activation notch signaling" (UROP).

Ryan Boyle, "Physiological response to degradation and permeability of alginate capsules" (SURP).

Eashani Sathialingam, "Understanding biophysical data to explain notch signaling" (SURP).

Danielle Behrens, "Physiological response to degradation and permeability of alginate capsules" (SURP).

Mentor: Dr. Zhongping Chen
Robert Dunn, "Optical coherence tomography imaging to find a correlation between age and biofilm accumulation in extubated endotracheal tubes as well as analyzing biofilm thickness from distal to proximal regions of endotracheal tubes" (SURP).

Mentor: Dr. Bernard Choi
Paul Akshay and **Edmund Florendo**, "Endoscopic laser speckle imaging system (ELSI)" (UROP).

Michael Marks, **Melinda Preedanon**, **Chris Case**, **Nick Sullivan**, **Alex Beed** and **Tung Le**, "Cheap autofocus fluorescent microscope" (UROP).

Patrick Lo and **Sneha Shivkumar**, "Permanent cranial window housing to enable glass slide replacement and long-term laser speckle imaging of superficial brain vasculature" (UROP).

Patrick Lo and **Thai Nguyen**, "Laser speckle contrast imaging using a consumer grade webcam" (UROP).

Thai Nguyen, "Laser speckle contrast imaging with Raspberry Pi" (SURP).

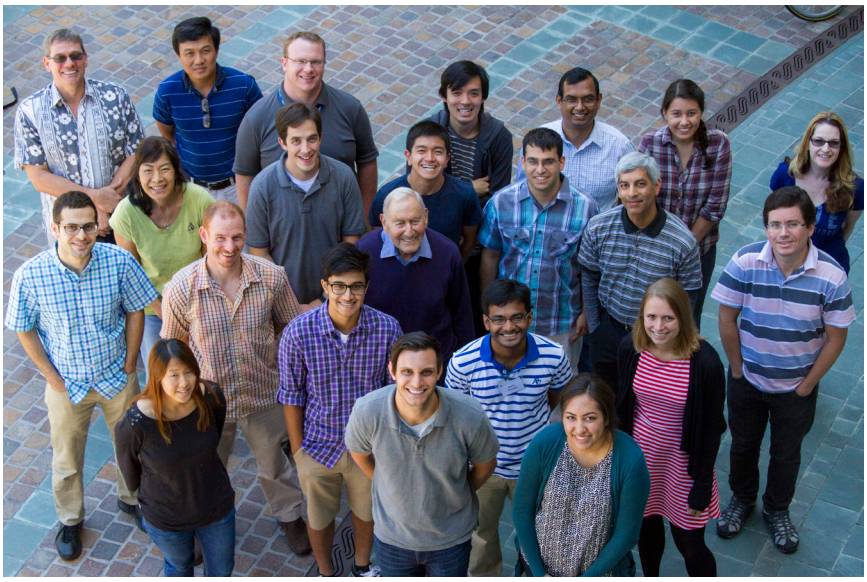
Prachi Shah, "Point of care laser speckle imaging device for blood flow imaging and quantification" (SURP).

Shinnosuke Fukazawa, "Developing low-cost wearable device to measure blood pressure and oxygen saturation level" (SURP).

(UROP and SURP continued on p. 8)

3rd Annual Short Course in Computational Biophotonics

The 3rd Annual National Short Course in Computational Biophotonics (SCCB) was held August 10-14, 2015, at the Beckman Laser Institute and Medical Clinic (BLI) and Natural Sciences II. A total of 17 trainees, ranging from a junior at an Irvine high school to seasoned postdoctoral researchers, attended the morning lecture sessions and participated in the afternoon tours of BLI labs. They also worked in teams of two on the laboratory exercises that were developed by the Virtual Photonics (VP) team to reinforce the learning acquired in the 10 lectures with hands-on computational exercises using the Virtual Tissue Simulator (VTS). This open-source software platform is in its sixth year of development by the VP software team (Dr. Carole Hayakawa, Dr. Janaka Ranasinghesagara, Ms. Lisa Malenfant, and Ms. Jennifer Nguyen working with VTS software architect Dr. David Cuccia). Profs. Vasan Venugopalan and Jerry Spanier, who co-direct the Virtual Photonics Technology Core within the Laser Microbeam and Medical Program (LAMMP) are the co-PIs of the National Institutes of Health (NIH) R25 grant that supports these Short Courses. They have guided the software team to broaden the VTS design to emphasize its educational uses rather than limiting it to the application of research problems. The success of these Short Courses serves as powerful testimony to this educational mission.



Computational Biophotonics short course students with instructors.

The 10 lectures were given by Profs. Venugopalan, Spanier and Bruce Tromberg, and Drs. Rolf Saager, David Cuccia, Mihaela Balu and Carole Hayakawa, whose disciplinary backgrounds encompass physics, mathematics, biomedical engineering, chemistry, electrical engineering, chemical engineering and software engineering. The VTS development team has combined their talents to create a platform that is platform-independent, extensible, and open source and provides a large spectrum of tools serving a broad biophotonics audience. Internationally, research in the development and utilization of biophotonics methods and technologies is increasing rapidly throughout the biomedical, physical sciences, and engineering communities. The Short Course focuses on the underlying principles of these methods and the development of advanced techniques for biophotonics modeling and optical signal analysis that are critical for the proper deployment of biophotonics tools and the interpretation of the measured optical signals.

Day 1 introduced physical and mathematical models for light transport in cells and tissues and oriented the students to the computational resources within VTS to be used in the laboratory sessions. The focus of Day 2 was to introduce the principles and applications of linear and non-linear optical microscopy for 3-D structural and functional imaging of thick cellular and tissue samples. Emphasis was placed on modeling the effects of scattering on focal field distortion, signal generation and propagation. The focus of Day 3 was on optical dosing in phototherapy and the connection between internal light fields and optical reflectance and transmittance that forms the basis of optical diagnosis and imaging. Day 4 introduced the use of spatially-resolved and spatial frequency domain methods for tissue imaging and spectroscopy while Day 5 considered time-resolved and temporal frequency domain approaches used in diffuse optics.

This year's trainees included Ms. Anouk Post, a Ph.D. candidate at the University of Amsterdam, and Prof. Adamo do Monte from the Federal University of Uberlândia, Brazil, both of whom travelled nearly 6000 miles to attend SCCB 2015. Fifteen others came from American universities in the northeast, southwest, and points in between. This year, there were two industrial participants from Cercacor, who were sponsored by UCI and BLI alumnus, Dr. Sean Merritt. An innovation this year was a panel discussion moderated by BLI and LAMMP Director Bruce Tromberg on "Industrial opportunities and challenges in biophotonics." The panel consisted of Dr. Merritt and three other UCI and BLI alumni, Dr. Joon You, CEO of Praxis BioSciences, Dr. David Cuccia, CTO & CEO of Modulated Imaging, Inc., and Dr. Samir Shreim, Algorithm Engineer at Masimo. The panel discussion followed the banquet dinner on August 11 which provoked a very lively discussion that the trainees found to be both inspiring and informative. ▪

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UROP and SURP *(cont'd from p. 6)*

Mentors: Drs. Anthony Durkin and Adrien Ponticorvo
Melissa Baldado, "Spatial frequency domain imaging of burn wounds in rat models" (SURP).

Mentors: Drs. Anthony Durkin and Rolf Saager
An Dang, "Development and validation of a portable, quantitative spectral skin imager" (SURP).

Mentor: Dr. Henry Hirschberg
Rohit Nair, "Photochemical internalization mediated transfection of macrophages: use as delivery vectors for suicide gene therapy" (SURP).

Mentor: Dr. Wangcun Jia
Junming Cai, "Numerical study of port wine stain treatment with OR-PAM imaging system" (SURP).

Mentor: Dr. Bruce Tromberg
Swaril Mathur, **Natalie Vold**, **Rayan Kansakar**, **Priya Gaur**, **Jacquelyn Monroe** and **Rachelle Pursell**, "Multispectral device for non-invasive intravascular hemoglobin measurement" (UROP).

Mentor: Dr. Petra Wilder-Smith
Valery Saikaly, "Early detection using in vivo non-invasive imaging technique: an alternate to surgical biopsy" (UROP) and "Laser speckle imaging for early detection of gingivitis" (SURP).

Afarin Golabgir Anbarani, "Prevalence of enamel demineralization: a screening study using clinical and imaging tools" (UROP) and "Developing a clinical capability for detecting enamel de- and remineralization" (SURP).

Carla Castro, "The effect of over-the-counter preventative toothpastes on their efficiency in biofilm removal via innovative imaging approaches" (UROP).

Sara Zadmehr, "Application of a novel auto-fluorescence imaging device for assessing early dentin caries" (SURP).

Jessica Ho, "Efficacy of dentifrices on early periodontal disease: Livionex Dental Gel vs. Crest Pro-Health" (SURP).

Fatemeh Khashai, "Effect of oral hygiene (OH), saliva production, saliva buffering capacity and saliva protein content on formation of biofilm" (SURP).

Mentor: Dr. Brian Wong
Katherine Do, "Evaluating the use of structure-from-motion in the 3D reconstruction of the human airway" (UROP).

David Ho, "Low-cost, quantitative 3D structural imaging of the nose and other facial features using open source software" (UROP).

Arlene Ho, "Evaluating the viability of the temporomandibular joint in culture and the effect of electromechanical reshaping" (UROP).