DukeBroadband

FITZPATRICK INSTITUTE FOR PHOTONICS / DUKE UNIVERSITY

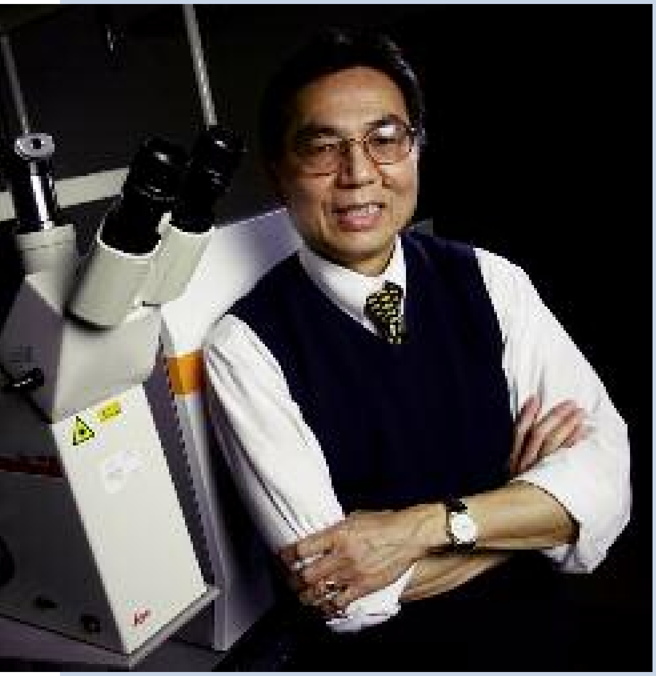
FIP FACULTY HIGHLIGHT
Kam Leong, NAE

istockphoto

Cross-border collaborations addressing
Global Challenges

2013 VOLUME 7 . ISSUE 1

Welcome to the Fall 2013 issue of BROADBAND, the newsletter of the Fitzpatrick Institute for Photonics (FIP). Due to the dedication and contribution of its faculty, students and staff, the FIP has continued to grow in research, education, industrial activities and membership. The membership of the Institute has increased to 92 faculty members belonging to 32 departments and institutions from the Pratt School of Engineering, the Trinity School of Arts & Sciences, and the Duke School of Medicine.



Professor Tuan Vo-Dinh

As international collaboration is an important element of our Institute's activities, we continue to establish the Institute's global outreach in partnerships with the *National Chiao Tung University* (Taiwan) and the *University of Saint Andrews* (UK), as well as the *Institut d' Optique* (France), the *Institute of Solar Fuels Research* (Germany) and more recently the *Institute of Applied Physics* IFNAC-CNR (Italy). Depicted in the image to the right (Google Maps Engine) is a partial list of FIP international collaborations with colleagues in over 22 countries across the globe.

This issue of BROADBAND highlights some of our faculty members who have worked with other colleagues outside the US, underlining their cross-border collaborations in order to address global challenges. This issue features Professor Kam Leong, who has worked with colleagues in Denmark, France and Africa to develop a more sensitive, non-invasive way to diagnose malaria in resource-poor areas, and Professor Christopher Woods, who established a global network of collaborators to study early detection of infectious diseases in developing countries. The newsletter also includes articles about Professor David Beratan's work with colleagues in Cyprus to develop electro-optical devices that allow electricity to be controlled with light for improved efficiency of solar energy harvesting and miniaturization of electronic devices. In addition, Professor Nimmi Ramanujam and Chambers Fellow Chris Lam are highlighted for working with teams in Haiti to develop portable, non-invasive devices that use white light to detect cervical cancer.

I invite you to visit our website at www.fitzpatrick.duke.edu to learn more about our faculty, research programs, and activities.

I hope you have a successful and enjoyable year.

Tuan Vo-Dinh

DIRECTOR, FITZPATRICK INSTITUTE FOR PHOTONICS
R. EUGENE AND SUSIE E. GOODSON PROFESSOR OF BIOMEDICAL ENGINEERING
PROFESSOR OF CHEMISTRY

NEW FIP FACULTY:

Haiyan Gao, Physics
Katherine Garman, Gastroenterology
Charles Gersbach, BME
Nico Hotz, MEMS
Andrew Janiak, Philosophy
Christopher Kelsey, Radiation Oncology
Bruce Klitzman, Plastic Max and Oral Surgery
Regis Kopper, DiVE
Maiken Mikkelsen, ECE and Physics
Greg Palmer, Radiation Oncology
Guillermo Sapiro, ECE
Thies Schroeder, Radiation Oncology
Hans Van Miegroet, Art History
Heather Whitson, Geriatrics

2014 FIP Annual Meeting March 10-11, 2014

KEYNOTE SPEAKER: Dr. Roger Y. Tsien, Nobel Laureate in Chemistry (2008)

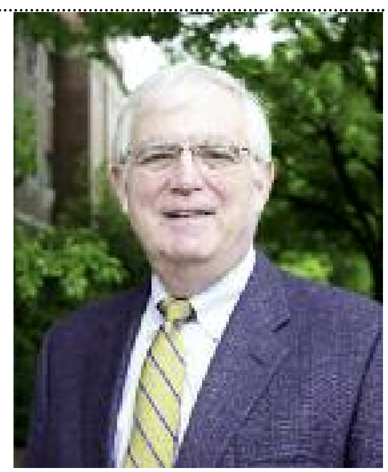
SPECIAL TOPIC SESSION:
"Visualization Across the Spectrum from Engineering to Humanities to Medicine"

Google Engine Map

THE FITZPATRICK INSTITUTE FOR PHOTONICS has collaborators all over the world from Belgium to Uruguay. A few of our FIP faculty are highlighted in this issue of *Broadband* for their global collaborations. Go to **fitzpatrick.duke.edu** to explore all of our **55 collaborators** in over **20 countries** with an interactive map from Google Earth.

"The articles in this newsletter illustrate the global impact of the research being undertaken by the Fitzpatrick Institute for Photonics. Duke faculty—particularly those working in photonics—can contribute greatly to finding solutions to our major global challenges including those in low- and middle-income countries. The work being done to discover simplified methods for diagnosis of infectious diseases is particularly noteworthy and of great importance to decreasing the burden associated with these diseases."

–**MICHAEL MERSON, M.D.**, Director, Duke Global Health Institute, Wolfgang Joklik Professor of Global Health



PARTICIPATING DEPARTMENTS AND INSTITUTIONS

92 FACULTY MEMBERS | 32 PARTICIPATING DEPARTMENTS & INSTITUTES AT DUKE UNIVERSITY:

- Anesthesiology
- Art History
- Biology
- Biomedical Engineering (BME)
- Center for Metamaterials & Integrated Plasmonics
- Cell Biology
- Chemical Biology
- Chemistry
- Civil & Environmental Engineering (CEE)
- Computer Science (CS)
- Dermatology
- Division of Infectious Diseases & International Health
- Duke Comprehensive Cancer Center
- Duke Immersive Virtual Environment (DiVE)
- Duke Human Vaccine Institute
- Electrical and Computer Engineering (ECE)
- Gastroenterology
- Geriatrics
- Institute for Genome Sciences & Policy
- Mathematics
- Mechanical Engineering and Materials Science (MEMS)
- Neurosurgery
- Oncology
- Ophthalmology
- Orthopaedic Bioengineering
- Pathology
- Pediatrics
- Philosophy
- Physics
- Radiation Oncology
- Radiology
- Surgery

A better malaria test

Worldwide, malaria infections are dropping, and infected patients have fewer parasites in their bodies. This is good news on the global health front, but it presents a challenge to caregivers—who need a better, more sensitive way to diagnose the disease.

Duke biomedical engineer **Kam Leong** and collaborators met this need with a new, non-invasive malaria test that pinpoints the parasite using a single drop of bodily fluid, usually saliva or blood. They are now working to commercialize the test.

This technique, known as rolling-circle enhanced enzyme activity detection (REEAD) and developed by **Birgitta Knudsen at Aarhus University in Denmark**, identifies the enzyme topoisomerase I (pTopl) present in the malaria-causing Plasmodium parasites by using a lab-on-a-chip (LOC) technology developed by Sissel Juul and Megan Ho in the labs of Leong and Knudsen. LOC devices combine several laboratory functions in a small chip designed to analyze small-volume fluid samples with high sensitivity.

The technology offers advantages over a common laboratory tool used to detect malaria—polymerase chain reaction (PCR), which replicates DNA to create a sample size large enough to detect the DNA of the Plasmodium parasite. This technique presents two problems: it requires extensive sample preparation and a heat source that alternates between low and high temperatures.

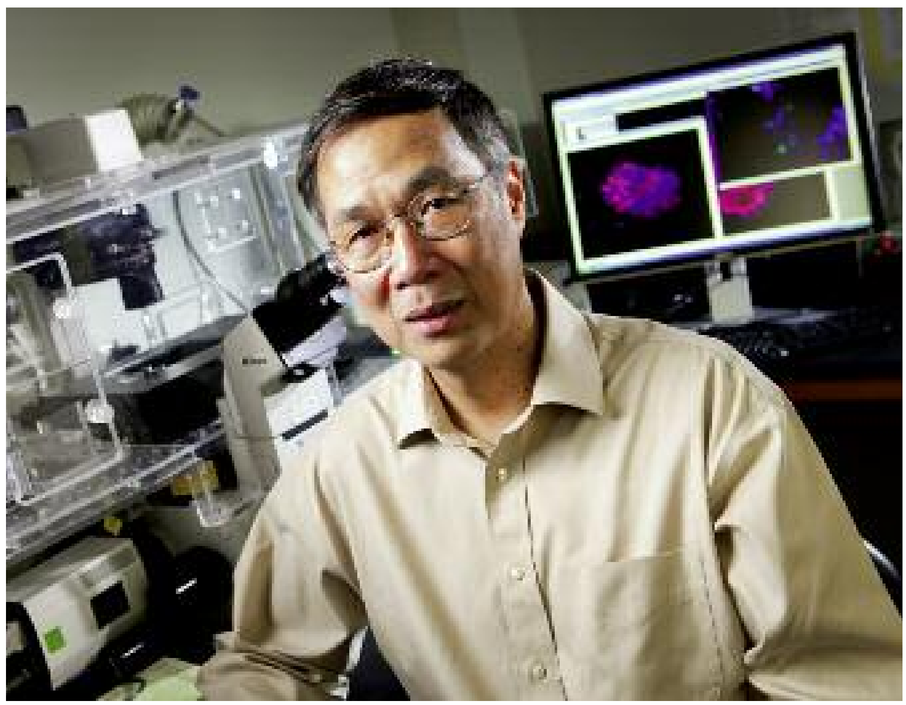
"The many temperature cycles needed means the process is often expensive and bulky," said Leong. "REEAD is much simpler, so it has a real advantage over PCR in remote, resource-poor areas."

REEAD is isothermal, he said. At room temperature it is sensitive enough to detect the pTopl enzyme in cells. Its detection limit is potentially less than one parasite per microliter of unprocessed body fluid, and it costs less because it doesn't need electricity or a clean water supply.

To test whether REEAD could identify pTopl in a small sample, Leong in collaboration with Knudsen's team encapsulated blood samples from 31 infected and uninfected individuals in water-in-oil droplets and, then, killed the cells with a low-salt solution. Next, they transferred the samples to a primer-coated slide and exposed them to light for optical detection of the pTopl signals.

The technique correctly identified all 20 malaria-infected blood samples, and it accurately pinpointed the four infected saliva samples from a group of 12.

Leong and his collaborators at Duke, as well as in **France**, **Denmark**, and **Africa**, are now adapting the technology for portability and functionality in visible, rather than ultraviolet, light. ■



Kam Leong

Leong Named NAE Member

Kam Leong is Duke's newest member of the National Academy of Engineering (NAE). Leong, the James B. Duke professor of biomedical engineering, was elected to the academy in 2013 for his outstanding contributions to engineered drug delivery and non-viral mediated gene delivery. He is noted for developing innovative, life-extending treatments for brain tumors and for expanding the use of nanotechnology in medicine.

Inset: Dr. Cecil H. Fox / Science Source

Chris Woods and color-enhanced photomicrograph showing infected red blood cells in a patient with malaria.

Rapid detection of infectious disease

Worldwide, HIV/AIDS, malaria, and tuberculosis account for roughly 5.5 million deaths annually and millions more new infections. Early identification is often critical to treating these diseases, and collaborative work between the Fitzpatrick Institute for Photonics (FIP) and the Duke Global Health Institute (DGHI) could make diagnosis easier.

According to **Chris Woods**, associate professor of infectious diseases, co-director of the Hubert-Yeargan Center for Global Health, and FIP member, swiftly pinpointing infections is a paramount – and largely elusive – capability. The lack of rapid identification in almost any location is a significant worldwide problem.

"One of the biggest hurdles facing global public health is the inability to quickly and accurately diagnose disease," said Woods, DGHI global health master's program director and Durham Veterans' Affairs infectious disease chief. "Our ultimate goal is a real-time, point-of-care detection device that allows us to make a decision about whether an individual has an active infection."

To reach this goal, Woods partnered with FIP director **Tuan Vo-Dinh**, building upon Vo-Dinh's previous work with surface-enhanced Raman scattering (SERS), a technique that shines laser light onto target molecules, encouraging them to vibrate and scatter back their own unique light. This proof-of-principle work uses light to spot infections before patients become symptomatic.

With funding from the National Institutes of Health, Defense Advanced Research Projects Agency, the Department of Defense and the Wallace H. Coulter Foundation, the researchers developed and added a silver-based nanoparticle with a DNA probe that attaches itself to a virus or bacteria's specific molecular markers that enter the bloodstream during early infection. When exposed to the SERS strategy, the nanoparticle exhibits a change in its distinctive light. According to Vo-Dinh, who has studied and developed SERS applications for decades, pairing a target molecule with a metal nanoparticle or nanostructure enhances the optical response by as much as a million times or more.

"Our ultimate goal is a real-time, point-of-care detection device that allows us to make a decision about whether an individual has an active infection."

Woods has been involved in many international collaborations to study infectious diseases worldwide: **Ruhuna University (Sri Lanka), the University Hospital (Nicaragua), the Institute Pasteur (Vietnam)** and the **National Institute of Health and Epidemiology (Vietnam)** to study dengue and other causes of acute febrile illness; **Duke-National University of Singapore (Singapore)** for pathogen discovery; **Moi University (Kenya)** to investigate epidemiology of malaria; **Kilimanjaro Christian Medical College (Tanzania)** to study bacterial zoonoses and HIV infections; and **Lola Ya Bonobo/Kinshasa School of Public Health (Democratic Republic of Congo)** to investigate zoonotic infections. The use of SERS diagnostics could lead to an advance in human diagnostics and has potential applications in Central American, East and West Africa, as well as other locations, such as Sri Lanka and Vietnam.

"We have demonstrated that the use of these nanoprobes can detect specific genetic materials taken from human samples," said Vo-Dinh, who is also the R. Eugene and Susie E. Goodson Distinguished Professor of Biomedical Engineering, as well as a chemistry professor.

Now, Woods said, the team, including **Geoffrey Ginsburg**, director of genomic medicine at the Duke Institute for Genome Sciences & Policy, is working to translate the technique to a chip that can be used in a portable diagnostic device and requires only a small number of genes, providing fast, accurate details about patient infections. Ultimately, he said, these tests could be used in outpatient clinics or emergency rooms, as well as modified for global use in rural areas.

This technique, Ginsburg said, could lead to devices that can measure several genome-derived markers and provide quick diagnosis at the bedside, especially in low-resource locations. Antimicrobial therapy efficacy and outcomes could improve, and physicians' ability to offer targeted treatments could improve, as well.

"This important study paves the way for the development of devices that measure multiple genome-derived markers that will assist with more accurate and rapid diagnosis of infection disease at the point-of-care," said Ginsburg, who is also the executive director of the Duke Center for Personalized Medicine. "Point of care diagnostics holds great promise to accelerate precision medicine and, more importantly, help patients in limited-resource settings gain access to molecular testing." ■

Duke-Cyprus collaboration could lead to electronic devices on an atomic scale

Shining light on electrons doesn't make them visible to the naked eye, but the illumination can control how these subatomic particles move. And, manipulating the light can also change the electron's activity.

For the first time, chemistry professor **David Beratan** and his collaborator from **Cyprus**, **Spiros Skourtis**, have shown that altering charge exchanges between donor-and-acceptor couplings is possible by vibrating the electrons' trajectory.

David Beratan

"We would like to control the flow of electrons for many reasons," Beratan said. "We would like to make an electro-optical device that allows us to control electricity with light or vice-versa. These kinds of switches in processors are useful."

Such developments could improve solar energy harvesting efficiency, he said. Increased molecular-level control over electronic devices could also lead to greater miniaturization. It's the international collaborations that continue to move this research forward – in addition to official partnerships, researchers meet frequently at global conferences, facilitating easy discussion of ideas.

With funding from the National Science Foundation and the Cyprus Research Promotion Foundation, Beratan's team uses light in two ways – as a source to energize and drive electrons around, and to shake the electron's pathways within the molecule. This process uses both visible and 400-nanometer wavelength infrared light. In one experiment, they employ three pulses of light to map the electron's activities. One pulse launches the electron, another shakes the molecule, and the third probes the electron's location.

By hitting electrons with infrared light and monitoring absorption changes, the team discovered shaking hydrogen bonds in the middle of the electron's path slows the particle as it moves from donor to acceptor. Understanding the slowdown could reveal how to redirect the electron, its paths and its capabilities.

"One of engineering's challenges is to make smaller devices that consume less energy and operate faster," Beratan said. "Sensors in these devices are generally electronic, so the challenge is how to design and build these things when they get really tiny. We're looking toward the day when we have electronic devices on the atomic scale." ■

Screening moves from lab to Haiti

Breast cancer diagnosis and treatment are advancing thanks to work from FIP biomedical engineering professor **Nimmi Ramanujam** and colleagues. The team illuminates removed breast tissue with non-ionizing, visible-to-ultraviolet-wavelength white light. Photons scatter through tumors or are absorbed by optically detectable cancer biomarkers, such as betacarotene, or blood.

Ramanujam's Monte Carlo feature extraction algorithm separates the diffuse reflectance spectrum—the range that light reflects at different wavelengths—into the tissue's absorption or scattering levels. This helps determine margin positivity.

Although white light can't penetrate tissue deeply, it's a non-destructive, simple-to-use tool in non-invasively penetrable areas, such as the breast, mouth, nasal cavity or cervix.

Duke PhD student and **John T. Chambers Fellow Christopher Lam**, pictured far right, is adapting this technology for cervical cancer screening in **Haiti**. A Duke Global Health Institute graduate and biomedical engineer, Lam builds various system components.

He hopes to miniaturize the system and make it more useful in a resource limited setting by reducing the required power needs. The goal: a battery- or mobile-technology powered device.

With Duke-Coulter Translational Partnership grant funding, Ramanujam founded **Zenalux** in 2006, commercializing her technology. The flagship product—a small spectroscopy system called the Zenascope—reduced Ramanujam's lab instruments to a 4-by-5-by-9 inch form. Zenascopes include a console, the Monte Carlo feature extraction algorithm, and a single-channel, pen-like probe.

Zenascopes illuminate tissue, collecting the reflectance spectrum. The real-time algorithm converts reflectance into intrinsic absorption and sampled-tissue scattering, enabling observation of quantified endpoints during experiments. The process takes milliseconds and facilitates real-time analysis, such as letting surgeons determine whether they've removed all cancerous tissue during breast-conserving surgery.

Future Zenascopes will self-calibrate for lamp fluctuations and have pressure-sensing capabilities for instant measurement capture, features added based on field experience using a similar system in Haiti. Ultimately, Ramanujam anticipates Zenascopes will expedite accurate bedside, real-time diagnoses, and reduce unneeded surgeries. ■

Nimmi Ramanujam, top; Family Health Ministries' women's health clinic team in Haiti

Solving health problems across continents

Following the Fitzpatrick Institute for Photonics' global expansion goal, FIP director **Tuan Vo-Dinh** has established collaborations in **Germany**, **Italy**, and **France**. These associations will allow investigators to work on cross-disciplinary projects, such as enhancing—at a molecular level—future personalized healthcare and improving energy production using sunlight. "Technology has allowed cross-continent collaborations that wouldn't have been practical 10 years ago," Vo-Dinh said.

Currently, Vo-Dinh works with **Joachim Lewerenz**, a senior scientist with the **Institute for Solar Fuel** in **Berlin (Germany)** and department head at Caltech's Joint Center for Artificial Photosynthesis (JCAP), to study how nanophotonics improves biosensors and solar fuel – particularly developing improved photocatalysis for the production of energy. The goal is to use metallic nanoparticles with a plasmonic effect to enhance photocatalysis to create fuel.

Additionally, Vo-Dinh collaborates with researchers at the **Institute of Applied Physics of the National Research Center (IFAP/CNR)** in **Florence (Italy)**. Alongside **Francesco Baldini**, head of the Chemical and Biochemical Optical Sensor group at IFAP/CNR, he investigates new applications of optical sensors for medical diagnostics. The project's main focus is aimed at developing and characterizing molecular probes consisting of short nucleic acid molecules with optical signals that can be turned on or off upon recognition of molecular biomarkers of disease. These nanoprobes can sense and image tumor cells, potentially enhancing individualized diagnostics and therapies.

According to Baldini, they use fluorescence and surface-enhanced Raman spectroscopy (SERS) to investigate the RNA messenger survivin, a protein – found in several tumors – that prevents cell death. The work holds significant promise for point of care diagnostics.

"Thanks to the experience of both our institutions on cellular analysis, there will be the possibility to apply the nanosensors in tumor cell lines by means of appropriate carriers for cellular delivery," Baldini said.

Vo-Dinh also partners with **Michael Canva**, head of the **Institut d'Optique** biophotonics group in **Paris (France)**. With both surface plasmon resonance sensing and SERS, they are designing and developing a unique medical diagnostics chip. Utilizing surface plasmon resonance imaging, these chips image and detect disease biomarkers. Chip bioreceptors bind to multiple biomarkers, thus allowing multiplex detection and improving medical diagnoses.

In addition to international collaborations, Vo-Dinh also impacts medicine via work with other U.S. institutions such as the Center for Applied Nanobioscience and Medicine at the University of Arizona. Combining Duke's biosensing expertise and University of Arizona's microbiology proficiency, they investigate treated blood samples, using biomarker-detecting technology.

"We are now entering an important epoch in science," Vo-Dinh said, "where the knowledge of individual research groups is no longer sufficient but should be combined and integrated across national borders and continents to solve complex problems of global importance." ■

Fitzpatrick Institute for Photonics Fellowships

The Fitzpatrick Institute for Photonics (FIP) is pleased to announce and introduce the recipients of the **John T. Chambers Scholars** and the **John T. Chambers Fellows** for the 2013 academic year thanks to the continued generosity and support of John T. Chambers.

2013-2015 John T. Chambers Scholars

Jenna Mueller
(BME – Professor Ramanujam)
Jong Kang Park
(Chemistry – Professor Therien)
Tana Villafana
(Chemistry – Professor Warren)

2013-2014 John T. Chambers Fellows

Brian Crouch (BME – Professor Ramanujam)
William Eldridge (BME – Professor Wax)
Yuan Fang (ECE – Professor Liu)
Derek Ho (BME – Professor Wax)
Lindsay McTague (ECE – Professor Cummer)
Dalton Sycks (MEMS – Professor Zhao)

L-R: Tana Villafana, Brian Crouch, Dalton Sycks, William Eldridge, Jenna Mueller, Yuan Fang, Derek Ho, Lindsay McTague, Jong Kang Park

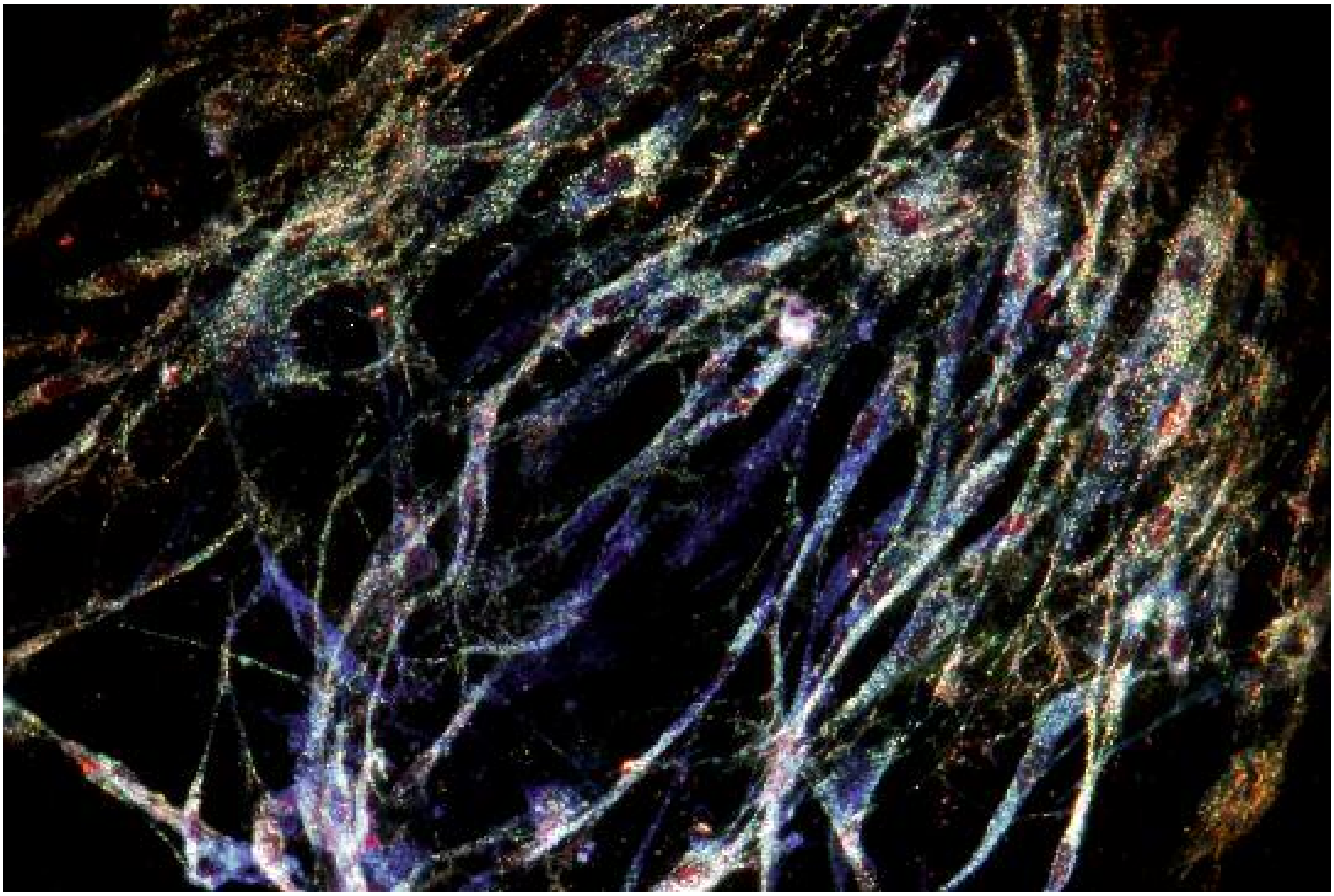
Chambers Fellows Where Are They Now?

After graduating with a Ph.D. in Electrical and Computer Engineering from Duke in 2009, **Zhiya Zhao** used the interdisciplinary knowledge and expertise in quantum dot infrared photodetectors he gained as a student to co-launch the **Kuang-Chi Institute of Advanced Technology in Shenzhen, China**.

As vice president, Zhao oversees research and development teams, merging physics, photonics, mathematics, materials and microelectronics, statistics, biology, and computer sciences experts to advance wireless communications.

Together, his team has developed several wireless communication and smart community products, featuring high security and strong directivity.

www.kuang-chi.org/



Nanoshells, appearing as tiny points of light, accumulate in tumor vessels.

A golden approach to killing cancer

Cancer treatment is notoriously brutal—which is why **Jennifer West**'s work is creating such a buzz. The Duke engineer has developed a way to kill tumors without the kinds of negative side effects associated with chemotherapy and radiation.

West and her team discovered that they could destroy soft-tissue tumors by injecting gold-covered nanoshells about 100 nanometers (nm) in size into the body, then heating them up with light. The method is currently being tested in three human clinical trials focused on prostate, lung, and head and neck cancers.

"From our animal trials, we saw a complete regression of tumors and no regrowth or adverse effects," West said. "This is different from using drugs because it's really a mechanical effect. You're not binding something to a biochemical—you're cooking something."

This method works, she said, because blood vessels that form quickly to support tumors are leaky, and they readily absorb the gold-covered nanoshells. The gold covering is 15 nm thick—laid on an inert silica core at the exact thickness and curvature needed to absorb infrared light. (One nanometer is approximately 1/75,000th the thickness of a human hair, or 1/8,000th the size of a red blood cell).

Jennifer West

Roughly 24 hours after injecting the nanoshells, researchers shine a 800 nm wavelength infrared light over the cancerous tissue for four minutes. The gold, the most biocompatible inertmetal, heats up and burns away the tumor.

The novel treatment is breaking new ground with the Food and Drug Administration, West said. It's one of the first nanotechnologies to seek agency approval, so they're navigating new regulatory waters. Her company, **Nanospectra Biosciences, Inc.**, hopes to bring a product to market within two years. ■

Seeing the eye in a new light

Duke engineers are illuminating a new medical era—literally—harnessing light's abilities to detect and manipulate biological materials. With medical center and university colleagues, they're developing healthcare solutions, from cancer diagnosis and treatment, to intrasurgical guidance and monitoring, to new disease biomarker-identification test design.

Joseph Izatt, Pratt's Fitzpatrick Institute for Photonics (FIP) biophotonics program director, and collaborators use optical coherence tomography (OCT) to improve treatments for eye disease. Early in his career, Izatt co-developed the first clinically viable OCT, a method that captures diagnostic, internal eye images using near-infrared light. Today, this $1 billion-per-year industry provides standard retinal diagnostic technology – and more potential remains.

In 2007, Izatt's company, **Bioptigen Inc.**, designed a handheld device capable of imaging 40 times faster than existing OCT equipment. Suddenly, ophthalmologists gathered previously elusive diagnostic images, including retinal views that were used to detect neonatal vision loss.

Recently, his team profiled individual cell membranes with nanosecond spatial and millisecond temporal resolution using OCT, monitoring "heartbeats" of individual heart muscle cells growing in culture.

Next, he said, they'll extend OCT to retinal microsurgery and provide real-time image guidance. OCT doesn't have this capability yet, but it's impactful, said Izatt's collaborator, Duke retinal surgeon **Cynthia Toth**.

"OCT images give you more retinal information before you begin surgery," she said. "So, you operate smarter, and it translates into better patient outcomes."

Particularly, she said, OCT helps surgeons repair vision-impairing macular holes in the retina's center. Imaging-provided details facilitate hole-formation analysis and choosing the best treatment. The team also plans to introduce OCT to cataract surgery, one of the most often-performed surgeries worldwide, Izatt said.

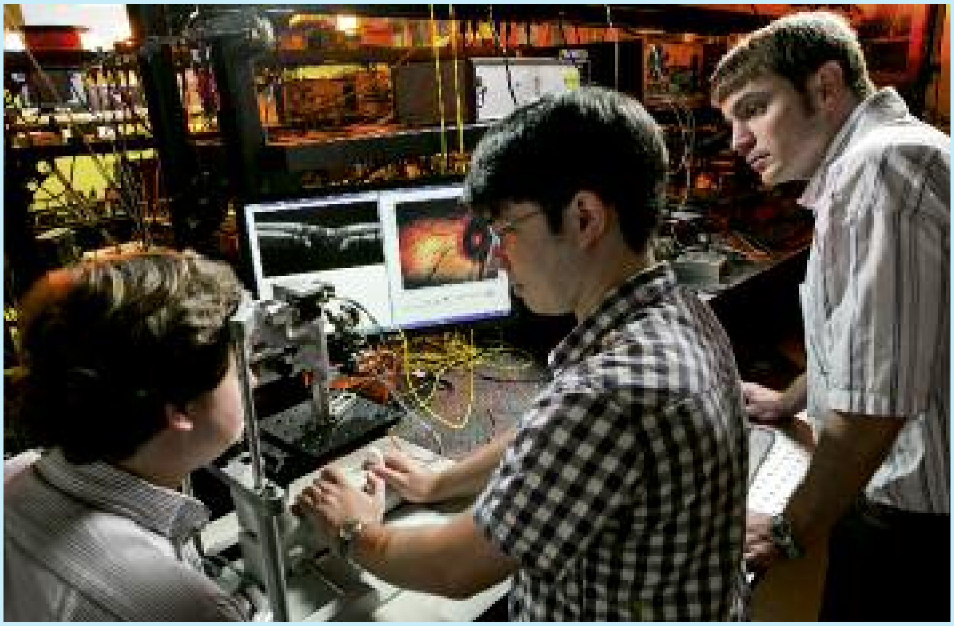
"In cataract surgery, surgeons replace an older patient's cloudy lens with a plastic one, but choosing the new lens correctly depends on knowing the patient's corneal power," he said. "Current corneal power measuring instruments weren't designed for people who've had vision-correction surgery, such as LASIK. Adapting OCT's three-dimensional imaging power in the front of the eye will help surgeons pick correct replacement lens for this growing population."

OCT's imaging speed and resolution capabilities have continually ballooned. New generations multiply imaging-dataset sizes, said **Sina Farsiu**, Duke's Vision and Image Processing (VIP) Laboratory director. The hardware produces substantial micron-level information, requiring computer-assisted analysis and research.

"Ophthalmologists get minutes with patients, and they don't have time to analyze all the images," he said. "They want data compressed into meaningful quantitative measurements—that's what I do."

Farsiu's computer-automated algorithms mine the diagnostic images Izatt's tools capture, searching for and quantifying disease biomarkers. "Recent improvements could impact diabetes-related blindness", he said. Currently, physicians try treatments via trial-and-error. Using Izatt's hardware and Farsiu's algorithm, the team hopes patient images encourage immediate identification of optimal biomarker-based treatments.

"OCT images give you more retinal information before you begin surgery. So, you operate smarter, and it translates into better patient outcomes."



Scanning laser ophthalmoscopy (SLO) and optical coherence tomography (OCT) are laser-based imaging systems used by ophthalmologists to detect retinal pathology. This system combines SLO and OCT in a single device. By acquiring high-speed SLO images simultaneously with OCT, retinal motion can be estimated and used to correct for patient motion within an OCT volume.

Shortly, Farsiu's algorithms may need to process more data. With a new Duke-led, multi-center National Institutes of Health grant, the team is designing hardware improvements to boost OCT imaging speed by another factor of 20 and remove scan-blurring motion artifacts, producing more, clearer images.

These developments have impact beyond the clinic, wooing talented biomedical and engineering research students to Pratt, said Izatt.

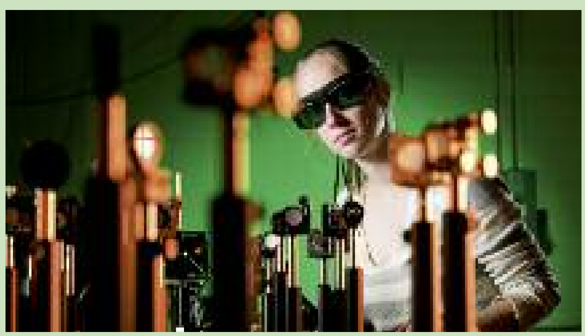
For example, **Fitzpatrick Scholar Derek Nankivil** uses OCT to study how the eye changes to maintain clear images and how older people lose focusing ability with close objects. Additionally, **Chambers Fellow Francesco LaRocca**, pictured below, combined confocal scanning laser ophthalmoscopy (CSLO) and OCT into a handheld device, producing high-resolution, low-artifact human retina images.

"For our projects, we've not only invented technologies to bring capabilities to physicians, but we've also increased our understanding of how body systems work," Izatt said. "Working on these endeavors gives students excellent training in biomedical science, optical engineering, and signal/image processing, because it takes a combination of those disciplines to make these advancements." ■

The 2013 FIP Annual Symposium *branched out* to include a student "Breakfast with a Nobel Laureate," "Women in Science and Engineering" workshop, and "Building Bridges Between Academia and The Federal Laboratory" workshop.

Local high school students from Broughton, Enloe Magnet, Franklin Academy, Garner Magnet, J.D. Clement Early College, Riverside, Sanderson, Southeast Guilford and Woods Charter high schools attended FIP's **breakfast with a Nobel Laureate. Dr. William D. Phillip**, awarded the 1997 Nobel Prize in Physics "for development of methods to cool and trap atoms with laser light", provided enlightenment and encouragement during an informal breakfast session. In addition, the students toured photonics and optics labs as well as the Duke Smart Home, a sustainable and LEED-certified dorm.

The workshop "Building Bridges Between Academia and The Federal Laboratory" explored potential collaborative opportunities between Oak Ridge National Laboratory and Duke in research and educational activities including the focus areas of nano-bio-technology, sensors and diagnostics, and supercomputing and big data.



Hannah Guilbert aligns an optical system for a quantum communication project.

The new "Women in Science and Engineering" workshop including faculty, postdocs, staff, graduate students and a high school student discussed ideas for encouraging more women to enter Science, Technology, Engineering and Math (STEM) fields. Two of the attendees also traveled to the 2013 Girls STEM ThinkTank Conference in Nashville, TN to gather more ideas to build upon.

Linked in

A Duke Green Certified Workplace, **Fitzpatrick Institute for Photonics (FIP) recently won $500 from the Duke Green Grant Fund.** The grant was applied to purchasing travel mugs for the FIP Breakfast. In a sustainable environment, FIP no longer provides disposable cups and members are required to bring their mug.

Check out our latest training program!

Master of Engineering Photonics and Optical Sciences

See the insert enclosed in this newsletter or visit

fitzpatrick.duke.edu/education

along with...

Certificate In Photonics for MS and PhD students

Curriculum: Photonics courses focused on technical areas of interest, a research presentation, and attendance at a minimum of four FIP seminars.

Ideal candidates: Doctoral students in any technical field who wish to gain greater depth of skill and exposure to photonics and optical sciences.

Duration: Flexible. Courses can be taken at any time during the student's tenure at Duke while working towards a primary degree.

and meet our first

MEng in Photonics Program student!

Michael Zarella is the first student of the new **Master of Engineering in Photonics program** at Pratt School of Engineering. In May 2013, Zarella graduated from the University of Rochester's Institute of Optics with a B.S. in Optical Engineering. There, he was a Xerox Research Fellow working in Dr. Andrew Berger's Biomedical Spectroscopy group. Now studying both photonics and business management, Michael Zarella has aspirations to start his own company developing optical devices for medical imaging and diagnostics.

FIP Corporate Partnership Program

The Fitzpatrick Institute for Photonics at Duke actively encourages close collaboration with our corporate partners and promotes technology transfer for economic development. The Corporate Partners Program is designed to strengthen interactions between our faculty and industrial partners and to enhance the translational aspects of our educational and research programs.
fitzpatrick.duke.edu/industry

HAMAMATSU Photonics

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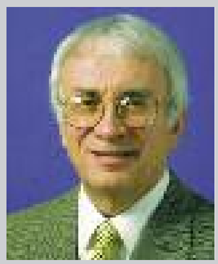
FACULTY SPINOFFS:



Advanced Liquid Logic, a start-up company founded by alumni Vamsee Pamula and Michael Pollack and **Richard Fair**, Lord-Chandran professor of electrical and computer engineering, has just been acquired by Illumina, Inc.
ece.duke.edu/advanced-liquid-logic

Other spinoffs from FIP faculty include:

- **Applied Quantum Technologies, Inc.** - Jungsang Kim, Electrical and Computer Engineering
- **Bioptigen, Inc.** - Joseph Izatt, Biomedical Engineering
- **Blue Angel Optics** (merged with Applied Quantum Technologies) - Bob Guenther
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