FIP FACULTY

The FIP faculty consists of more than sixty faculty members from over twenty departments and institutions at Duke.

ANESTHESIOLOGY
Allan Shang, M.D. Assist. Prof.

BIOMEDICAL ENGINEERING
Ashutosh Chilkoti, Prof.
Barry Myers, M.D., Prof.
Nimmi Ramanujam, Assoc. Prof.
Jingdong Tian, Assist. Prof.
George Truskey, Prof.
Adam Wax, Assist. Prof.
Fan Yuan, Assoc. Prof.
Tuan Vo-Dinh, Prof.
Joseph Izatt, Assoc. Prof.
Kam Leong, Prof.
William (Monty) Reichert, Prof. Dir.
Daniel Gauthier, Prof.
Hisham Massoud, Prof.
Farshid Guilak, Assist. Prof.
G. Allan Johnson, Prof.

CHEMISTRY
Tuan Vo-Dinh, Prof.
William (Monty) Reichert, Prof.
Jo Rae Wright, Prof.
David Beratan, Prof.
Martin Fischer, Assist. Res. Prof.
Jie Liu, Assoc. Prof.
Richard A. Palmer, Prof.
John Simon, Prof.
Warren Warren, Prof.
Weitao Yang, Prof.

CELL BIOLOGY
Jo Rae Wright, Prof.

CHEMICAL BIOLOGY
William (Monty) Reichert, Prof.

COMPUTER SCIENCE
Thomas LaBean, Assoc. Prof.
John Reif, Prof.
Xiaobai Sun, Assoc. Prof.
Nikos Pitsianis, Assoc. Res. Prof.

DUKE COMPREHENSIVE CANCER CENTER
Victoria Seewaldt, Assoc. Prof.
Neil L. Spector, M.D. Faculty

ELECTRICAL AND COMPUTER ENGINEERING
David Brady, Prof.
Rachael Brady, Res. Sci.
Martin Brooke, Assoc. Prof.
April Brown, Prof.
Krishnendu Chakrabarty, Prof.
Leslie Collins, Prof.
Steve Cummer, Assoc. Prof.
Chris Dwyer, Assist. Prof.
Richard Fair, Prof.
Jeff Glass, Prof.
Nan Jokerst, Prof.
Jungsang Kim, Assist. Prof.
Jeffrey Krolik, Prof.
Qing Liu, Prof.
Sule Ozev, Assist. Prof.
David R. Smith, Prof.
Adrienne Stiff-Roberts, Assist. Prof.
Tomoyuki Yoshie, Assist. Prof.
Hisham Massoud, Prof.
Nikos Pitsianis, Assoc. Res. Prof.

INSTITUTE FOR GENOME SCIENCE & POLICY
Geoffrey Ginsburg, M.D. Prof.

MATHEMATICS
Stephanos Venakides, Prof.

MECHANICAL ENGINEERING AND MATERIALS SCIENCE
Rob Clark, Prof.
Anne Lazarides, Assist. Prof.

NEUROSURGERY
Gerald Grant, M.D. Assist. Prof.

ONCOLOGY
Victoria Seewaldt, Assoc. Prof.
Neil L. Spector, M.D. Faculty

ORTHOPAEDIC BIOENGINEERING
Farshid Guilak, Assist. Prof.

OPHTHALMOLOGY
Joseph Izatt, Assoc. Prof.

PATHOLOGY
Gayathri Devi, Assist. Prof.

PEDIATRICS
Judith Voynow, M.D. Assoc. Prof.

PHYSICS
Harold Baranger, Prof.
Glenn Edwards, Prof.
Daniel Gauthier, Prof.
Bob Guenther, Res. Sr. Sci.
John Thomas, Prof.

RADIATION ONCOLOGY
Mark Dewhirst, D.V.M. Prof.

RADIOLOGY
G. Allan Johnson, Prof.
James Provenzale, M.D. Prof.

SURGERY
Gayathri Devi, Assist. Prof.
Kam Leong, Prof.

UPCOMING EVENTS

FIP Seventh Annual Meeting

October 11-12, 2007 - Schiciano Auditorium

Symposium on Photonics in the Translational Era: Science and Technology for a Purpose

Invited Keynote Speaker:

John H. Marburger, III

Science Advisor to the President of the United States of America and Director of the Office of Science and Technology

Plenary Speaker:

Sir John Pendry

Chair, Theoretical Solid State Physics
Imperial College, London
United Kingdom

OTHER INVITED SPEAKERS:

Harry Atwater, California Institute of Technology
Pierre Berini, University of Ottawa, Canada
Olivier J.F. Martin, Swiss Federal Institute of Technology
Vladimir Shalaev, Purdue University
Costas Soukoulis, Iowa State University
Richard VanDuyne, Northwestern University
Xiang Zhang, University of California at Berkeley

REGISTRATION and details: www.fitzpatrick.duke.edu

DukeBroadband

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Fitzpatrick Institute for Photonics
305 Teer Building, Box 90271
Durham, NC 27708-0271

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DukeBroadband

FITZPATRICK INSTITUTE FOR PHOTONICS • DUKE UNIVERSITY

Student Spotlight

Ellerbee receives 2007 Golden Torch Award

"Going nano"

Jokerst Leads Development of New Cleanroom Facility

The new Duke Shared Materials Instrumentation Facility (SMIF) is a key enabling resource that will help realize a vision for nano-opto-bio-info integration that joins SMIF to the Fitzpatrick Institute for Photonics (FIP). *Story continued on page 4*

Tuan Vo-Dinh

It is my great pleasure to introduce the first issue of BROADBAND, the newsletter of the Fitzpatrick Institute of Photonics (FIP). FIP is now officially a Duke Institute and world class leader in important and emerging areas of photonics, the science and technology related to the interaction between light and matter. The Institute integrates the broad ranging, cross-disciplinary faculty strengths in photonics research.

As we are at the early years of a new century, I believe that photonics is a research area uniquely suited to address the challenges and fulfill the promises of a new era. We are focused on cultivating the next technology revolution at the nexus of the nano-bio-info-opto convergence.

Please join us at The 7th Annual Meeting of the FIP on October 11-12, 2007 at Duke University, Durham, North Carolina. We are hosting a Symposium titled "Photonics at the Translational Era: Science and Technology for a Purpose." Please visit our website at **fitzpatrick.duke.edu** to learn more.

My best wishes for an enjoyable and successful 2007 Fall Semester.

Tuan Vo-Dinh
FIP DIRECTOR AND PROFESSOR

RESEARCH PROGRAM DIRECTORS

biophotonics
Joseph Izatt

nano & micro systems
Nan Jokerst

nanophotonics
Kam Leong

quantum information
Daniel Gauthier

advanced photonics systems
William Reichert

novel spectroscopies
Warren Warren

systems modeling
Weitao Yang

photonics materials
David R. Smith

2006-2007 HIGHLIGHTS

- **Increased faculty membership** in FIP from 25 in 2006 to 60 faculty members belonging to 16 departments and institutions from the Pratt School of Engineering, the School of Arts & Science, and the School of Medicine at Duke.
- **Promoted cross-disciplinary translational research** by establishing new collaborative projects with other institutions (e.g., Duke Comprehensive Cancer Center).
- **Established a Task Force on Education** to expand the FIP Graduate Certificate in Photonics (GCP) program and develop an integrated photonics education program in collaboration with various departments.
- **Organized the Sixth Annual Meeting** on September 28-29, 2006, with keynote lecture delivered by Dr. Charles Townes, Nobel Laureate in Physics and inventor of the laser.
- **Established a Corporate Partnership Program** to strengthen interactions between FIP faculty and industrial developers. Several major photonics companies, including Nortel, Hamamatsu, Newport-Spectra Physics, and New Focus have joined as FIP corporate partners.
- **Promoted regional economic development, photonics education and growth of the photonics industry in the Carolina region.** The FIP is a founding member of the Carolina Photonics Consortium (CPC), which comprises Duke University, the University of North Carolina at Charlotte, North Carolina State University, Western Carolina University and Clemson University.

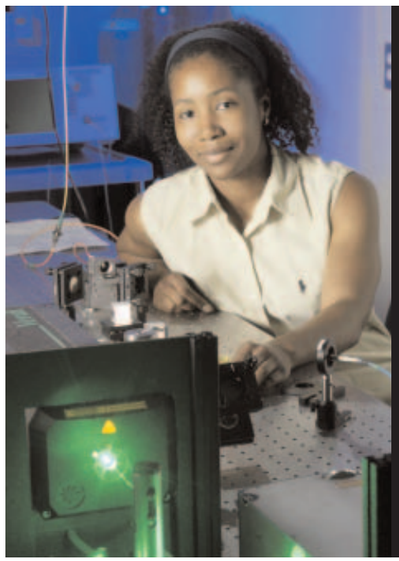
Chambers Fellows

The John Chambers Fellowship program is part of the The John T. Chambers Scholarship Endowment Fund which provides scholarship money for graduate engineering students interested in Fitzpatrick Institute research who have demonstrated excellence in both their classroom activities and their participation in Duke activities. David Sebba (MEMS), Candong Cheng (ECE), Bogdan Popa (ECE), Matthew Crow (BME) and Gunay Yurtsever (BME)

Education Task Force

The FIP Educational Task Force (Co-chaired by Professors Dan Gauthier, Joe Izatt and Jungsang Kim) has been strengthening Photonics education at Duke University across departmental boundaries. The Photonics related courses offered at graduate and undergraduate level has expanded dramatically since the inception of the Institute, with more than 16 courses on the topic of Photonics offered by five different departments on a regular basis today. About half of these courses have strong laboratory components offered at the Institute's state-of-the-art Photonics Teaching Laboratory, providing our students with opportunity for hands-on learning experience. Key foundation courses at both undergraduate and graduate levels are cross-listed among multiple departments. The Photonics Certificate program is offered to the Graduate students by the Institute, and has seen expansion in enrollment over the last few years.

Jungsang Kim, Ph.D.
Nortel Networks Assistant Professor
Electrical and Computer Engineering Dept.



Audrey Ellerbee receives 2007 Golden Torch Award

Audrey Ellerbee, a Ph.D. student in the laboratory of biomedical engineering professor Joseph Izatt, was selected Graduate Student of the Year by the National Society of Black Engineers. She received her 2007 Golden Torch Award at the NSBE's national meeting in Columbus, Ohio, in March. This significant honor recognizes Ellerbee's academic and extracurricular contributions.

Ellerbee's research is focused on optical coherence tomography (OCT), and her work is supported by an NSF graduate research fellowship, the Duke Endowment, a James B. Duke fellowship and the University Scholars program. She earned her B.S.E. in electrical engineering from Princeton in 2001 and taught for a year in Singapore before coming to Duke.

Following graduation in August, Ellerbee will begin the year as winner of the prestigious 2007-2008 Optical Society of America/International Society for Optical Engineering Congressional Fellowship in Washington, D.C. Typically, fellows conduct legislative or oversight work, assist in congressional hearings and debates, prepare briefs and write speeches as a part of their daily responsibilities. By applying her scientific expertise in this policy environment, Ellerbee will help to broaden awareness of the value of scientist- and engineer-government interaction.

Jokerst Leads Development of New Cleanroom Facility

Nan Jokerst

The new cleanroom nanofabrication facility includes intrumentation like electron beam lithography system with viability to write 10 nm feature sizes, and a bio-bay that enables the integration of biological media with more traditional semiconductor materials.

SMIF characterization facilities include a new Cryo-TEM geared toward both biomedical and materials imaging. While Duke plans to hold an official dedication of the facility in the spring of 2008, faculty, graduate students and industry researchers are moving in now and undergoing training.

Director **Mark Walters** and Executive Director and Professor **Nan Jokerst** teamed with existing faculty users of a smaller facility to create a unique user resource both for Duke and the Triangle community.

SMIF will enable research aims such as Jokerst's research into integrated chip scale photonics, an area of emphasis at the FIP. Chip scale integrated optical systems are emerging as an enabling technology for portable sensor systems. These systems need to integrate an optical source, optical interconnections, and sensing or signal processing elements, optical sensors, readout of the optical sensor, and, in many cases, signal processing circuitry and a wireless communication link. Thus, a fundamental goal for chip scale photonics is the integration of active optoelectronic devices and passive waveguide structures at the board and chip levels within the constraints of the manufacturing environment for low cost electronics.

Heterogeneous integration, one method of integrating photonic active devices into systems, enables the system designer to integrate independently optimized optoelectronic and passive components onto arbitrary substrates, including epoxy printed wiring board, glass, polymers, Si, and Si CMOS ICs. The heterogeneous integration technologies employed by Jokerst's research group utilize compound semiconductor devices that are separated from the growth substrate through selective etching. These thin film devices (nanometers to microns thick) are then integrated onto substrates such as a Si CMOS integrated circuit, or can be embedded in a polymer planar photonic structure. The integration of a vertical optical source (a resonant cavity enhanced light emitting diode) onto a Si CMOS IC with analog control and digital signal processing circuitry as well as Si CMOS photodetectors enables the direct control of this bi-directional optical system using on-chip circuitry.

This highly collaborative work engages the disciplines of photonics and integration (Jokerst), analog circuits (Martin Brooke, Duke University), and digital circuits (D. S. Wills, Georgia Tech). The addition of a sensor between a point to point interconnection, such as a microring sensor will complete a chip scale integrated planar photonic sensing system. In addition, first steps toward the integration of a photonic system with a microfluidics system has been demonstrated at Duke, for a low cost, portable malaria diagnostic tool using photonics and integration (Jokerst), digital microfluidics (Richard Fair, Duke University), and microbiology and medicine (Debra Schwinn, University of Washington).

The new clean room facilities of the

Duke Shared Materials Instrumentation Facility (SMIF)

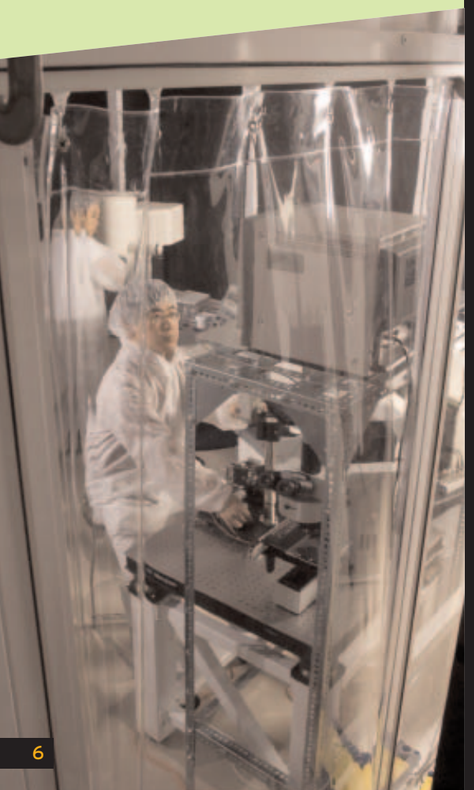
will be an outstanding resource addition for all

FIP faculty at Duke University. -TUAN VO-DINH

NANOPHOTONICS RESEARCH

Yoshie Lab

The Yoshie Research Group is led by electrical and computer engineering assistant professor **Tomoyuki Yoshie**, an expert in the field of nanophotonics, particularly photonic crystal devices. The group is working on three-dimensional optical micro-circuits and on-chip solid-state cavity quantum electrodynamics (QED). Three-dimensional optical micro-circuits hold great promise for optical signal processing chips and high-data-rate chip-to-chip optical interconnection. The study of light localization in a 3D photonic crystal can also provide deep insight into our ability to handle information represented by light in a limited size. Yoshie's research team designs, fabricates and tests one of the smallest resonators and laser diodes. The team is also improving quantum coherence with a single quantum dot in a photonic crystal nanocavity, aiming at building novel quantum devices and advancing the state-of-the art in quantum information processing technology.



Victoria Seewaldt, M.D

BREAST CANCER RESEARCH

Seewaldt Lab

Oncologist **Victoria Seewaldt, M.D.**, and bioengineering professor **Tuan Vo-Dinh** are working to prospectively investigate the biology of breast cancer initiation and to develop nanobiosensors for early cancer detection. The team is collaborating to develop nanobiosensors to test for real-time dysregulation of apoptotic signaling in live mammary epithelial cell cytology and to use the novel technology on live mammary cells directly obtained from women in a high-risk cohort. Seewaldt's research group also includes proteomics researcher **Catherine Ibarra**, **Neil Spector, M.D.** who specializes in targeted agent development. The combined expertise and resources of this collaboration provides a unique opportunity to use novel nanobiosensor technology to prospectively investigate the origins of human breast cancer in live mammary epithelial cells the moment cells are removed from the breast of well characterized high-risk women. The nanobiosensor technology developed in this study can be rapidly expanded to test for multiple signal transduction pathways and further refined to better target prevention strategies. The advance will also provide proof-of-principle to drive development of nanbiosensor-based targeted imaging.

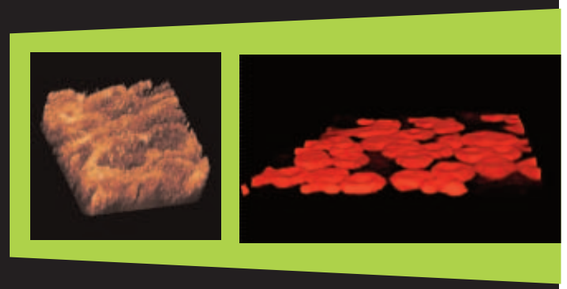
"Through partnerships between members of the Duke Comprehensive Cancer Center and faculty from the Fitzpatrick Institute for Photonics, investigators have created unique synergies in which knowledge and expertise are shared, and complimentary strengths are engaged to expand the opportunities for exciting discoveries in science and medicine."

- H. KIM LYERLY, MD
Director, Duke Comprehensive Cancer Center

NONSURGICAL SCREEN FOR SKIN CANCER

Warren Lab

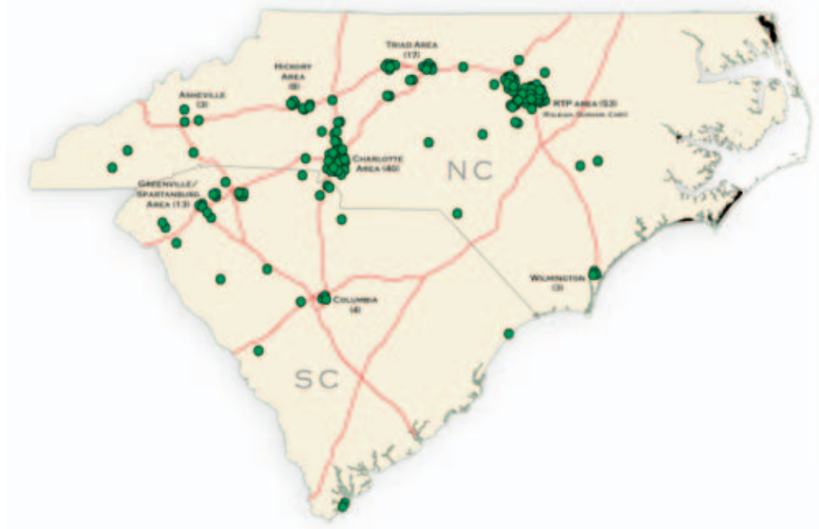
Duke researchers led by chemist **Warren Warren** have demonstrated a laser-based system that can capture three-dimensional images of the chemical and structural changes under way beneath the surface of human skin. Warren's team developed a technology for detecting both hemoglobin and melanin inside questionable skin moles to emit light by exciting them with highly controlled laser pulses. The innovation uses a delicate interplay between two laser beams, each emitting femtosecond laser pulses of different colors and deploys technology Warren's group has developed and refined over the last decade-complete control over the amplitude and frequency modulation of such pulses. The noninvasive technique could enable doctors to see as much as a millimeter below the skin's surface—more than enough for diagnosis. Warren S. Warren is the James B. Duke Professor of Chemistry, Radiology, and Biomedical Engineering, Duke University.



Picture 1 is an image of hemoglobin cells using the two-color excited state absorption technique;

Picture 2 is a picture of a human cancerous lesion, highlighting only the melanin distribution.

PHOTONICS FACILITIES IN THE CAROLINAS



CPC - Carolina Photonics Consortium

Carolina Photonics Consortium and Regional Economic Development

Duke University has teamed with North Carolina State University, the University of North Carolina at Charlotte, Western Carolina University, and Clemson University to form the Carolinas Photonics Consortium (CPC). Representatives of each university signed a CPC Inter-Institutional Agreement to establish a foundation for collaborative university work aimed at the commercialization of photonics or light-based technologies.

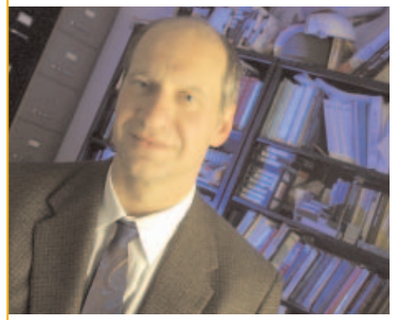
"This is a tremendous opportunity to bring science and technology into the service of society–to translate research from the idea stage to the bench top and ultimately into use on the 'street'." - TUAN VO-DINH

"This is a tremendous opportunity to bring science and technology into the service of society—to translate research from the idea stage to the bench top and ultimately into use on the 'street' so to speak," said Tuan Vo-Dinh, director of Duke's Fitzpatrick Institute for Photonics in the Pratt School of Engineering. "Each of the partner institutions brings complementary research strengths to the table and we believe that photonics is a strong platform for growth in this region of the state and country."

Photonics researchers from CPC member institutions can now compete for seed money to refine their technology ideas into commercially ready products. In addition, researchers will receive entrepreneurship and business planning advice. One of the primary goals of the CPC is commercialization of photonics-based research by awarding funds to competitively submitted proposals from the five campuses.

Photonics-based technologies are used in a wide array of everyday products, including: DVD players, long distance communication, medical and dental surgeries, dash board lighting, missile guidance, and garage door sensors. Photonic technologies are being used to compliment or replace electronics in almost every facet of our lives. Recent advances include high intensity lighting, biochemical detection, high powered lasers for manufacturing needs, and early cancer detection.

"Photonics technology has the potential to change everything from communications to process control to patient care and Duke's Fitzpatrick Institute is positioned to provide the kind of market facing innovations that will drive that change."



– BARRY S. MYERS, MD, PH.D, MBA
Senior Associate Dean for Industrial Partnerships and Research Commercialization, and Professor

FIP CORPORATE PARTNERSHIP PROGRAM

A main goal of the FIP Corporate Partnership Program is to strengthen its industrial relations programs in the coming years in order to encourage need-driven research and further develop technology transfer programs. In this activity the FIP works closely with the Office of Corporate Industrial Relations at the Pratt School of Engineering at Duke.

PLATINUM

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