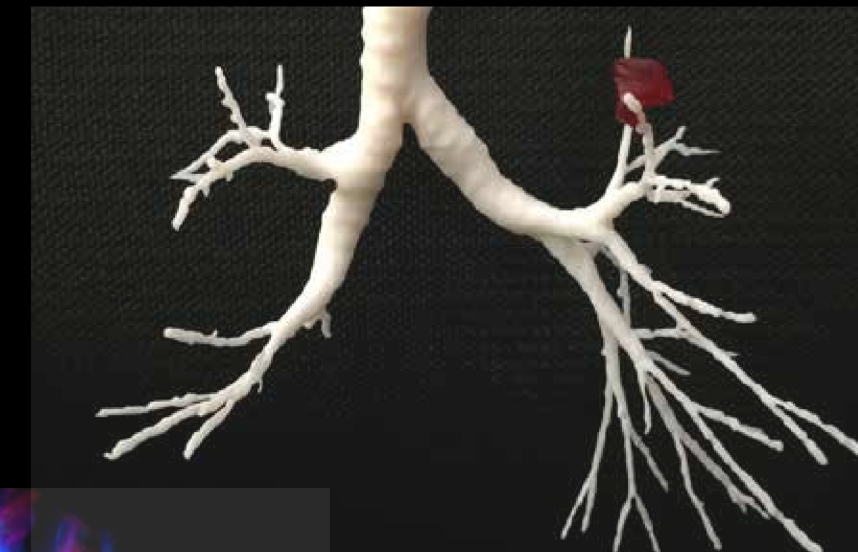

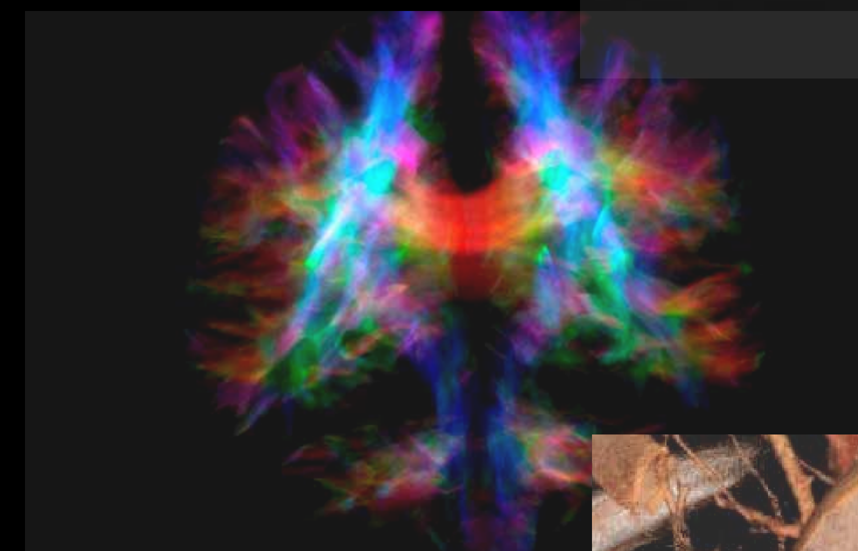

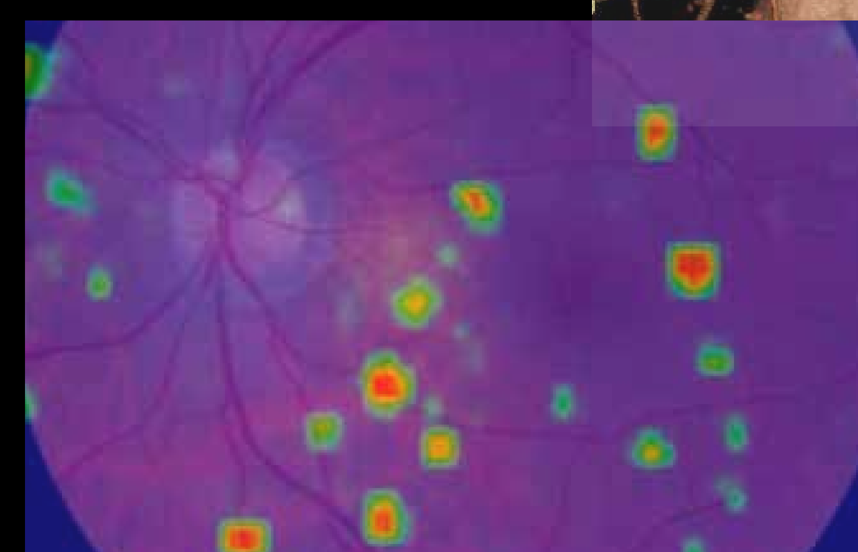

Radiology Department Report 2015–2017

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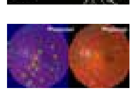
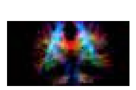
Top to Bottom:

3D printed, high resolution, solid representation of airway; intended to demonstrate bronchoscopic pathway to lesion (red).
Image courtesy H. Henry Guo, MD, PhD.



Deep learning model automatically detects and outlines tiny retinal hemorrhages, color coding suspected areas in color (red = suspicious), with the suspicious areas matching well that determined by an expert physician.
Image courtesy the Rubin lab.



A coronal view of the brain showing color-coded orientations of white matter fiber pathways measured by diffusion MRI (blue:S-I; green: A-P; red: L-R).
Image courtesy the McNab lab.

Thin-slab volume-rendered image of CT Angiography heart and great vessels.
Image courtesy Dominik Fleischmann, MD.

Contents

http://radiology.stanford.edu/about/annualreport/

From the Chairman

Dr. Sanjiv Sam Gambhir
Chair, Department of Radiology

THE STANFORD DEPARTMENT OF RADIOLOGY continues to thrive in an ever-changing and challenging world. In my last message to you through the 2014–15 Annual Report, I shared examples of the department's achievements in multiple new areas of clinical, educational, and research expansion. This growth matches our most aggressive expectations and positions the department to be an outstanding clinical and research entity at Stanford.

Implemented through our truly outstanding faculty, staff, and trainees, we continue to push the boundaries of what radiology, as a field, will offer in the years ahead. Key themes of my chairmanship have included "Science Without Borders", which creates significant bridges to scientific and clinical activities throughout the medical school, affiliated hospitals, and across the Stanford campus. Earlier this year, we formally announced two important new initiatives: (1) The Precision Health and Integrated Diagnostics (PHIND) Center at Stanford, and (2) Project Baseline. While distinctly different initiatives, the PHIND Center and Project Baseline both introduce new concepts to healthcare and build on the long-held belief that precision health can help us move away from the position of being more reactive to being more proactive. Unlike precision medicine, precision health focuses on risk assessment, prevention, and early disease detection. We need to move the entire healthcare field towards a precision health strategy, and both the PHIND Center and Project Baseline will help us to do just that.

The new PHIND Center (page 112–113) is dedicated to longitudinal monitoring and improvement of overall human health by studying the fundamental biology underlying early transitions from health to disease and the biomarkers of health and early disease. The long-term goal of the Center is to develop, test, and disseminate the next generation of healthcare strategies and mechanisms focused on precision health by integrating diagnostic information collected from multiple sources both on the body and in one's home.

The second initiative, another major milestone in 2017, was the launch of Project Baseline, a collaboration between Verily/Google (Alphabet), Stanford Medicine, and Duke University School of Medicine (page 111). The project will gather comprehensive health information on 10,000 participants to better understand health and the transition to disease, including cancer and heart disease.

We have made remarkable progress in key research areas that we believe are important to healthcare in the long-term. These areas include: (1) Early disease detection as one of our strategies for moving from precision medicine towards precision health (e.g., early lung cancer screening). (2) Theranostics through the use of technologies such as MR-high intensity focused ultrasound (MR-HIFU) and through radiochemistry with imaging agents that serve as both diagnostics and therapeutics. (3) Multimodality imaging through strategies that combine the best of what each modality has to offer (e.g., MR + PET; ultrasound + photoacoustics). (4) Bringing together in vitro diagnostics with in vivo diagnostics for improved patient care (e.g., lung cancer detection and management through the use of CT, PET-CT, and circulating tumor cells). (5) Increased clinical trials bringing new instrumentation and new imaging agents to the clinic. (6) Breast tomosynthesis for improved breast imaging. (7) Pediatric oncologic imaging strategies with PET-MR that reduces radiation burden relative to PET-CT while still providing similar accuracy. (8) Novel strategies for improving cardiovascular imaging including 4D visualization and 3D printing for improved patient care. (9) Imaging informatics/artificial intelligence for extracting more useful information from medical data/images as well as combining information from different disciplines (e.g., genomics, pathology, and radiology). (10) Start-up companies to take academic discoveries and research to the private sector creating jobs and eventually allowing strategies pioneered at Stanford to be made available worldwide.

With the opening of many new facilities, and the expansion of existing ones, our growth in space and facilities, in particular for our clinical needs, has been remarkable. In recent years, we have experienced high growth of our clinical imaging capabilities. With the anticipated opening of the Lucile Packard Children's Hospital Expansion in December 2017, the planned construction completion of the new Stanford Hospital in early 2019, the newly added outpatient sites, and a commitment to keeping our imaging sites up-to-date, we have purchased more imaging equipment than ever before (pages 36–37). During the last three years alone, we have acquired 15 new clinical MRIs. Our ability to use the most cutting-edge equipment ensures that we can achieve our commitment to the highest levels of patient care.

> "... we continue to push the boundaries of what radiology, as a field, will offer in the years ahead."
>
> SANJIV SAM GAMBHIR, MD, PHD

Regarding research space: We are in the process of updating several sites, including the Lucas Center, the Clark Center, and the Porter/Canary Center facility with upgrading, or siting new equipment (that is microscopes, a microCT scanner, and magnetic particle imaging (MPI)). At the Canary Center facility, we are siting new equipment ranging from imaging to mass spectroscopy to stereomicroscopy. To manage these very active facilities, Dr. Heike Daldrup-Link, who was recently appointed to lead all Radiology small animal imaging sites, works closely with Drs. Doyle, Pisani, and Habte to keep all facilities operating at the highest level and to accommodate many users' schedules and their varied research needs.

The growth in our faculty is a reflection of the department's commitment to excellent patient care and advancing research. Since 2016, we are pleased to welcome twenty-three outstanding new faculty, ten instructors, and twenty adjunct, affiliated, courtesy, or part-time faculty. Each new faculty addition not only fills a particular gap in a specific area in the department, but also brings fresh energy and an enriched perspective to the team. Please see pages 16–27 for information about each new faculty member—and be sure to keep an eye out for them throughout your day and welcome them to our Radiology family!

With a need to increase efficiencies for a rapidly expanding department, we have restructured leadership as of August 1, 2017: (1) Dr. Garry Gold named Vice Chair of Research and Administration. (2) Dr. David Larson named Vice Chair of Education and Clinical Services. (3) Dr. Juergen Willmann named Vice Chair of Strategy, Finance and Clinical Trials. This newly formed leadership model will share department responsibilities to begin a new era of partnership with me in leading a radiology department that is rapidly expanding on all fronts. There are several other changes as well, including the naming of Dr. Heike Daldrup-Link, Associate Chair for Diversity; Dr. Wendy DeMartini, Division Chief of Breast Imaging; Dr. Payam Massaband, Associate Chair and Chief of Radiology at the VA Palo Alto Health Care System (VAPAHCS); and Dr. Christopher Beaulieu, Associate Chair of Education (taking over for Dr. Michael Federle effective January 2018). As we have further discussions on department leadership throughout this calendar year, there are likely to be additional changes announced later in 2017 and early 2018.

Ten faculty searches are currently in progress and include: (1) Three positions in Pediatric Radiology: a director of pediatric interventional radiology, a pediatric radiologist and medical director for clinical operations, and a clinical pediatric radiologist; (2) Two positions

2017

director of pediatric interventional radiology, a pediatric radiologist and medical director for clinical operations, and a clinical pediatric radiologist; (2) Two positions in Nuclear Medicine: a nuclear medicine/molecular imaging physician scientist and a targeted radionuclide therapy expert; (3) One position in IBIIS (Integrative Biomedical Imaging Informatics at Stanford): a machine learning expert; (4) Three positions in Breast Imaging: one located in the East Bay and two at other Stanford Health Care (SHC) sites; and (5) One basic scientist for the Canary Center at Stanford for Cancer Early Detection and the Stanford Cancer Institute. We are also in the process of launching several new physician, physician-scientist, and basic scientist faculty searches in the next few months.

We are at the final stages of several faculty searches, including: a basic scientist in the Molecular Imaging Program at Stanford (MIPS), a basic scientist with the Radiological Sciences Laboratory (RSL) at VA Palo Alto, a physician-scientist to serve as director of Pediatric Neuroimaging, and a physician to serve as director of Pediatric Nuclear Medicine. We hope to successfully complete these searches in the coming months.

We have also expanded our scientific leadership staff since 2015: (1) Dr. Mark Stolowitz joined Dr. Stephanie van de Ven as Deputy Director of Operations for the Canary Center at Stanford for Cancer Early Detection; (2) Dr. Gunilla Jacobson was named Deputy Director of the Molecular Imaging Program at Stanford (MIPS); (3) Dr. Praveen Gulaka was named Deputy Director of the PET-MRI Service Center; (4) Dr. Ryan Spitler joined the department as Deputy Director of the newly established Precision Health and Integrated Diagnostics (PHIND) Center; and (5) Dr. Rajan Munshi was named Deputy Director of Scientific Program Management.

Furthermore, Dr. Gary Glover has stepped down as Division Chief of the Radiological Sciences Laboratory (RSL) after twenty-four years of extraordinary service (1990–2014) and Co-Division Chief of RSL (since 2014). He continues to serve as the head of the Lucas MRI Service Center, and to run an active laboratory where he helps to mentor faculty and trainees. We thank Dr. Glover for his outstanding and dedicated service. Dr. Kim Butts Pauly, Co-Division Chief of RSL since 2014, is now the sole Division Chief of RSL.

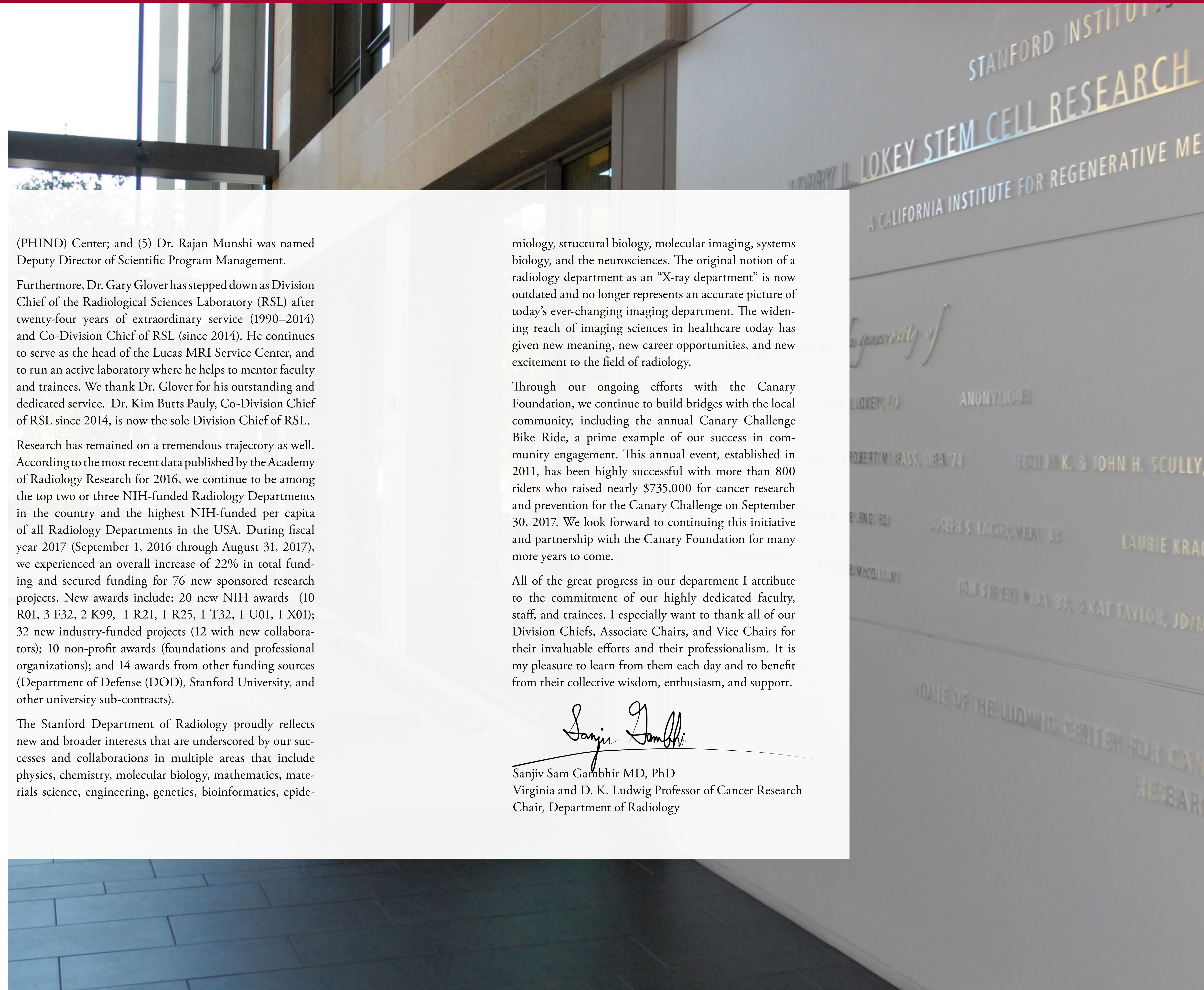
Research has remained on a tremendous trajectory as well. According to the most recent data published by the Academy of Radiology Research for 2016, we continue to be among the top two or three NIH-funded Radiology Departments in the country and the highest NIH-funded per capita of all Radiology Departments in the USA. During fiscal year 2017 (September 1, 2016 through August 31, 2017), we experienced an overall increase of 22% in total funding and secured funding for 76 new sponsored research projects. New awards include: 20 new NIH awards (10 R01, 3 F32, 2 K99, 1 R21, 1 R25, 1 T32, 1 U01, 1 X01); 32 new industry-funded projects (12 with new collaborators); 10 non-profit awards (foundations and professional organizations); and 14 awards from other funding sources (Department of Defense (DOD), Stanford University, and other university sub-contracts).

The Stanford Department of Radiology proudly reflects new and broader interests that are underscored by our successes and collaborations in multiple areas that include physics, chemistry, molecular biology, mathematics, materials science, engineering, genetics, bioinformatics, epidemiology, structural biology, molecular imaging, systems biology, and the neurosciences. The original notion of a radiology department as an "X-ray department" is now outdated and no longer represents an accurate picture of today's ever-changing imaging department. The widening reach of imaging sciences in healthcare today has given new meaning, new career opportunities, and new excitement to the field of radiology.

Through our ongoing efforts with the Canary Foundation, we continue to build bridges with the local community, including the annual Canary Challenge Bike Ride, a prime example of our success in community engagement. This annual event, established in 2011, has been highly successful with more than 800 riders who raised nearly $735,000 for cancer research and prevention for the Canary Challenge on September 30, 2017. We look forward to continuing this initiative and partnership with the Canary Foundation for many more years to come.

All of the great progress in our department I attribute to the commitment of our highly dedicated faculty, staff, and trainees. I especially want to thank all of our Division Chiefs, Associate Chairs, and Vice Chairs for their invaluable efforts and their professionalism. It is my pleasure to learn from them each day and to benefit from their collective wisdom, enthusiasm, and support.

Sanjiv Sam Gambhir MD, PhD
Virginia and D. K. Ludwig Professor of Cancer Research
Chair, Department of Radiology



In Memoriam

Herbert Abrams, MD (1920–2016)

Dr. Abrams was an internationally renowned pioneer in radiology. He was Professor and Director of Diagnostic Radiology at Stanford from 1960 to 1967, and was then appointed and served as the Philip H. Cook Professor and Chairman of Radiology at Harvard University from 1967 to 1985. He returned to Stanford in 1985 as Professor of Radiology to focus most of his time on research. He retired in 1990 as Professor of Radiology, Emeritus, but was recalled part-time from 1992 to 2008.

A recognized expert on cardiovascular radiology, Dr. Abrams, Dr. Abrams authored nearly 200 papers and seven books on cardiovascular disease and health policy, and was founding Editor-in-Chief of the journal *CardioVascular and Interventional Radiology*. His 1961 text book *Angiography*, the first comprehensive volume on the subject, is in its 4th edition (edited by Dr. Stanley Baum) under the title *Abrams' Angiography: Vascular and Interventional Radiology*.

Dr. Abrams also served as the Editor-in-Chief of the journal *Postgraduate Radiology* (1980–1999). He was an Honorary Fellow of the Royal College of Radiology of Great Britain and the Royal College of Surgeons of Ireland. Dr. Abrams was awarded the 1984 Gold Medal of the Association of University Radiologists, the 1995 Gold Medal from the Radiological Society of North America (RSNA), and the 2000 Gold Medal from the Society of Cardiovascular and Interventional Radiology in recognition of his lifetime achievements in cardiovascular radiology.

A member of the Institute of Medicine of the National Academy of Sciences, Dr. Abrams was also founding vice-president of International Physicians for the Prevention of Nuclear War (IPPNW) in 1980. The group's primary goal was to educate and publicize the health risks and consequences of nuclear war, and to counter theories that physicians might be able to save enough people to continue civilized life. Dr. Abrams later called nuclear weapons and nuclear war "the central health issue of the 20th century." This group received the UNESCO Prize for Peace Education in 1984, followed by the Nobel Peace Prize in 1985. He also served for 20 years on the National Board of Directors for Physicians for Social Responsibility (PSR), and was also National Co-Chairman during the 1980's.

According to Scott Sagan, Professor of Political Science at Stanford, "his contributions were huge," including his "work to try to educate both the public and world leaders about the consequences of nuclear weapons use." Further, in the 1990s, Dr. Abrams began to also focus on the occurrence of Presidential/World Leader disability and its potential impact on decision-making. He lectured every year at Stanford on how the physical and psychological health of leaders influenced their decision-making about war and peace.

Dr. Herb Abrams passed away on January 20, 2016. His colleagues across the nation and in unison can only describe him as "a class act—a gentleman and a scholar for all time."

Gerald Friedland, MD (1933–2016)

Gerald Friedland, MD, a professor emeritus of Stanford Department of Radiology passed away on April 2, 2016 in Los Gatos, California. He was 82.

Dr. Friedland received his medical degree from the University of Pretoria, South Africa, and completed his medical training in Scotland, Cambridge, and London before moving on to London's Great Ormond Street Hospital for Sick Children. He led a career as a clinical radiologist, researcher, and administrator. He authored or co-authored more than 100 medical articles and 35 book chapters and contributed to four books.

Dr. Friedland joined Stanford as an Instructor in 1966, became an Assistant Professor in 1968, and was promoted to Associate Professor in 1972. He left Stanford in 1975 to become the Director of Diagnostic Radiology and Professor of Radiology at Wake Forest University's Bowman Gray School of Medicine in North Carolina. In 1978, he returned to Stanford as Professor of Radiology and in the early 1980's became Chief of what is now the VA Palo Alto Health Care System until his retirement as Professor of Radiology, Emeritus, in 1992. He received a Lifetime Achievement Award from Stanford and organized the first *Pioneering Efforts of Women in Medicine and the Medical Sciences* conference in 2000.

In Dr. Friedland's early years, his clinical focus was on pediatric radiology and radiologic gastroenterology, but later he became interested in uroradiology and research. He developed a way to use ultrasound to image the urethras and prostates of patients with spinal cord injuries, and provided definitive information on the structure of the esophagus. His research at VA Palo Alto resulted in significantly reducing radiation exposure to abdominal and reproductive organs.

Dr. Gerald Friedland was truly an extraordinary individual. His passing is a great loss to the department and to the Stanford community as a whole. Dr. Friedland will be profoundly missed by everyone whose lives he touched; he was a kind soul, an excellent physician, an ethical researcher, and a true scholar.

F. Graham Sommer, MD (1946–2016)

Source: McGill University Reporter, http://publications.mcgill.ca/reporter/2016/09/gift-from-dr-graham-sommer-establishes-canada-wide-music-composition-competition/

Graham Sommer, MD, Professor of Radiology, Emeritus, at Stanford University School of Medicine, passed away on October 2, 2016, at the age of 70 of amyotrophic lateral sclerosis (ALS). With Mozart playing in the background, he died peacefully at his home on the Stanford campus, surrounded by family, friends, and his beloved cats.

A dedicated clinician and researcher, an avid bicyclist, golfer, skier, hiker, wine connoisseur, world traveler, and musician, Dr. Sommer was, above all, a friend to many here at Stanford and elsewhere. Dr. Michael Federle, a colleague, friend, and golfing partner, commented, "He lived life to the fullest."

Dr. Sommer grew up in British Columbia, Canada, received his BS degree from the University of Victoria in 1968 and his MD degree from McGill University in 1972. He did research training in Biomedical Engineering at Stanford from 1972 to 1973 before going to UCSF for his residency training in radiology from 1974–1977. He remained at UCSF to complete his fellowship in ultrasound, CT, body imaging, and genitourinary radiology in 1978. Dr. Sommer was then appointed Assistant Professor at Yale University, where he stayed for one year before returning to Stanford in 1979 as Assistant Professor of Radiology.

Widely known as an expert in ultrasound and magnetic resonance imaging (MRI), much of Dr. Sommer's research focused on blood flow to vital organs as well as imaging and treatment of the prostate. His interests in radiology were diverse, as were his interests outside of the field. In fact, by his own admission and with his own unique brand of humor, he characterized himself as a "Renaissance radiologist."

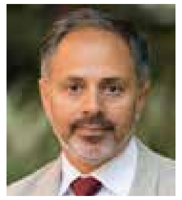
His wife, Denise Leclair, described him as "… a driven man. He had such a hungry mind; it drove him." His inquisitive nature surrounding medicine was balanced by his love for music. Dr. Sommer was an accomplished classical pianist and composer who played events frequently, including the local Filoli Mansion, a country estate in Woodside, California. His legacy is closely linked to that love of music as exemplified by his 2016 pledge of $1 million to McGill University to fund a Canada-wide competition for composers. Separately, he also established the *Dr. Sommer International Scholarships in Medicine* in 2006, which are awarded to outstanding international students there. Dr. Sommer had a history of finding ways to express his fondness for and to help McGill University, notably with the *Dr. Graham Sommer Piano Fund*, which helped to restore pianos in the University residences.

Recently, Dr. Sommer was honored for his dedication to radiology by his colleagues and the Academy for Radiology and Biomedical Imaging Research with the 2016 Distinguished Investigator Award.

Dr. Graham Sommer will be remembered in the department and in life as a distinguished physician, an accomplished musician and as a gentle man with a thoughtful, caring nature.

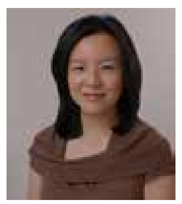
Department Leadership

Office of the Chair



Sanjiv Sam Gambhir, MD, PhD

Chair, Department of Radiology
Division Chief, Molecular Imaging Program at Stanford
Division Chief, Canary Center at Stanford for Cancer Early Detection
Director, Precision Health and Integrated Diagnostics Center at Stanford



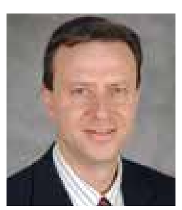
Yun-Ting Yeh

Director, Finance and Administration

Garry Gold, MD

Vice Chair, Research and Administration
September 1, 2017 to Present

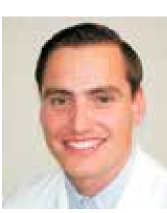
Associate Chair, Research
2012 to 2017



David Larson, MD, MBA

Vice Chair, Education and Clinical Operations
September 1, 2017 to Present

Associate Chair, Performance Improvement



Juergen Willmann, MD

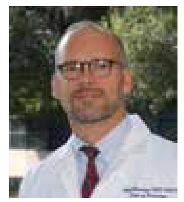
Vice Chair, Strategy, Finance, and Clinical Trials
September 1, 2017 to Present

Division Chief, Body Imaging

Associate Chairs

Richard Barth, MD

Associate Chair, Pediatric Imaging
Radiologist-in-Chief, LPCH
Division Chief, Pediatric Imaging



Christopher Beaulieu, MD, PhD

Associate Chair, Clinical Education
January 1, 2018 to Present

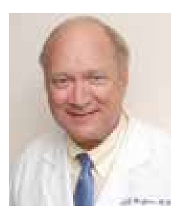
Division Chief, Musculoskeletal Imaging

Heike Daldrup-Link, MD

Associate Chair, Diversity

Michael Federle, MD

Associate Chair, Education



Robert Herfkens, MD

Associate Chair, Clinical Technology

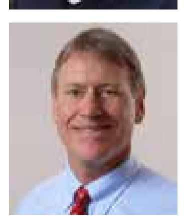
R. Brooke Jeffrey, MD

Associate Chair, Academic Affairs

Vice Chair
2010 to 2017

Curtis Langlotz, MD, PhD

Associate Chair, Information Systems



Volney Van Dalsem, MD

Associate Chair, Outpatient Imaging and Community Radiology

Ann Leung, MD

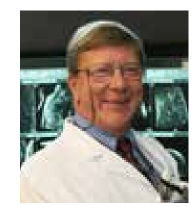
Associate Chair, Clinical Affairs
Division Chief, Thoracic Imaging

Payam Massaband, MD

Associate Chair and Division Chief, Radiology
VA Palo Alto Health Care System

Bruce Parker, MD

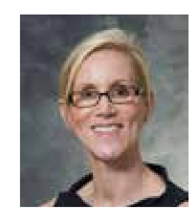
Associate Chair, Special Projects



Hans Ringertz, MD, PhD

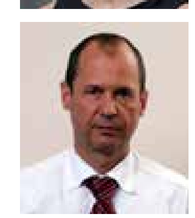
Associate Chair, Special Projects

Division Chiefs



Wendy DeMartini, MD

Division Chief, Breast Imaging



Dominik Fleischmann, MD

Division Chief, Cardiovascular Imaging

Lawrence “Rusty” Hofmann, MD

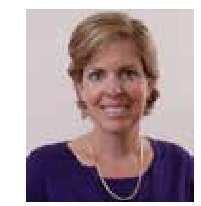
Division Chief, Interventional Radiology

Andrei Iagaru, MD

Division Chief, Nuclear Medicine and Molecular Imaging

Sandy Napel, PhD

Co-Division Chief, Integrative Biomedical Imaging Informatics at Stanford

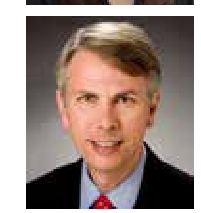


Kim Butts Pauly, PhD

Division Chief, Radiological Sciences Laboratory

Sylvia Plevritis, PhD

Co-Division Chief, Integrative Biomedical Imaging Informatics at Stanford

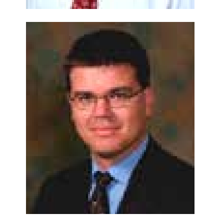


George Segall, MD

Division Chief, Nuclear Medicine
VA Palo Alto Health Care System

Shreyas Vasanawala, MD, PhD

Division Chief, Body MRI



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Adjunct Clinical Instructor

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Bruce Daniel, MD
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Terry Desser, MD
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Ahmed El Kaffas, PhD
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Michael Federle, MD
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Gabriela Gayer, MD
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David Gross, MD
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Howard Harvin, MD
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Michael Hollett, MD
Adjunct Clinical Assistant Professor

Raymond M. Hsu, MD
Adjunct Clinical Instructor

R. Brooke Jeffrey, MD
Professor

Aya Kamaya, MD
Associate Professor

Edward Lo, MD
Clinical Instructor

Robert Mindelzun, MD
Emeritus

Linda Nayeli Morimoto, MD
Clinical Assistant Professor

Bhavik Patel, MD, MBA
Assistant Professor

Peter Poullos, MD
Clinical Associate Professor

Sheena Prakash, MD
Clinical Instructor

Andrew Shon, MD
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Volney Van Dalsem, MD
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Juergen Willmann, MD
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Michael Yang, MD
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Wendy DeMartini, MD
Professor

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Jafi Lipson, MD
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Lisa Schmelzel, MD
Clinical Assistant Professor

Xin Ye, MD
Clinical Instructor

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Sanjiv Sam Gambhir, MD, PhD
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Don Listwin, BEng
Adjunct Professor

Parag Mallick, PhD
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Viswam Nair, MD
Clinical Assistant Professor

Sharon Pitteri, PhD
Assistant Professor

Johannes Reiter, PhD
Instructor

H. Tom Soh, PhD
Professor

Tanya Stoyanova, PhD
Assistant Professor

Cardiovascular Imaging

Christoph Becker, MD
Professor

Frandics Chan, MD, PhD
Associate Professor

Dominik Fleischmann, MD
Professor

Sanjay Gupta, MD
Adjunct Clinical Instructor

Richard Hallett, MD
Clinical Instructor

Horacio Murillo, MD, PhD
Adjunct Clinical Instructor

Koen Nieman, MD, PhD
Associate Professor

Humberto Wong, MD
Adjunct Clinical Instructor

Integrative Biomedical Imaging Informatics (IBIIS)

Benedict Anchang, PhD
Instructor

Curtis Langlotz, MD, PhD
Professor

Sandy Napel, PhD
Professor

David Paik, PhD
Adjunct Lecturer

Sylvia Plevritis, PhD
Professor

Daniel Rubin, MD, MS
Associate Professor

Interventional Radiology

Richard Baxter, MD
Adjunct Clinical Associate Professor

Lawrence (Rusty) Hofmann MD
Professor

Richard Hong, MD
Adjunct Clinical Instructor

David Hovsepian, MD
Clinical Professor

Gloria Hwang, MD
Clinical Associate Professor

Ibrahim Idakoji, MD
Clinical Instructor

Andrew Kesselman, MD
Clinical Instructor

Nishita Kothary, MBBS
Associate Professor

William Kuo, MD
Associate Professor

John Louie, MD
Clinical Associate Professor

Charles P. Semba, MD
Adjunct Professor

Taiyo Shimizu, MD
Clinical Assistant Professor

Daniel Sze, MD, PhD
Professor

Linda Tang, MD
Adjunct Clinical Assistant Professor

David Wang, MD
Clinical Assistant Professor

Molecular Imaging Program (MIPS)

Vikram Bajaj, PhD
Adjunct Professor

Carolyn Bertozzi, PhD*
Professor

Joshua Cates, PhD
Instructor

Zhen Cheng, PhD
Associate Professor

Frederick Chin, PhD
Assistant Professor

Sanjiv Sam Gambhir, MD, PhD
Professor

Edward Graves, PhD*
Associate Professor

Stefan Harmsen, PhD
Instructor

Sharon Hori, PhD
Instructor

Michelle James, PhD
Assistant Professor

Jeff Kleck, PhD
Adjunct Professor

Shivaani Kummar, MD
Professor

Craig Levin, PhD
Professor

Ying Lu, PhD*
Professor

Sanjay Malhotra, PhD
Associate Professor

Vivek Paul, MBA
Adjunct Professor

Ramasamy Paulmurugan, PhD
Associate Professor

Jianghong Rao, PhD
Professor

Stephan Rogalla, MD
Instructor

Eben Rosenthal, MD
Professor

* Courtesy Appointment

Ajit Singh, PhD
Adjunct Professor

Bryan Smith, PhD
Instructor

Geoffrey Sonn, MD*
Assistant Professor

Ananth Srinivasan, PhD
Adjunct Professor

Shan Wang, PhD*
Professor

Katheryne Wilson, PhD
Instructor

Joseph Wu, MD, PhD
Professor

Musculoskeletal Imaging

Christopher Beaulieu, MD, PhD
Professor

Sandip Biswal, MD
Associate Professor

Wilson Chang, MD, PhD
Adjunct Clinical Assistant Professor

Joseph DeMartini, MD
Clinical Associate Professor

Garry Gold, MD
Professor

Amelie Lutz, MD
Assistant Professor

Payam Massaband, MD
Clinical Assistant Professor

Connie Montgomery, MD
Adjunct Clinical Instructor

Geoffrey Riley, MD
Clinical Associate Professor

Kathryn Stevens, MBBS
Associate Professor

Sabrina Ward, MD
Adjunct Clinical Instructor

Neuroimaging and Neurointervention

Raag Airan, MD, PhD
Assistant Professor

Patrick Barnes, MD
Professor

Michael Brant-Zawadzki, MD
Adjunct Clinical Professor

Jenny Hui Jie Chen, MD
Adjunct Clinical Instructor

Wilson Chwang, MD, PhD
Adjunct Clinical Instructor

Hisham Dahmoush, MBBCh
Clinical Instructor

Huy Do, MD
Professor

Mircea Dobre, MD
Adjunct Clinical Instructor

Robert Dodd, MD, PhD
Assistant Professor

David Douglas, MD
Adjunct Clinical Instructor

Nancy Fischbein, MD
Professor

Ethan Foxman, MD
Adjunct Clinical Assistant Professor

Bo Yoon Ha, MD
Clinical Assistant Professor (Affiliated)

Syed Hashmi, MD
Clinical Instructor

Jeremy Heit, MD, PhD
Clinical Assistant Professor

Michael Iv, MD
Clinical Assistant Professor

John Jordan, MD
Adjunct Clinical Professor

Sirisha Komakula, MBBS
Adjunct Clinical Assistant Professor

Bryan Lanzman, MD
Clinical Instructor

Conway Lien, MD
Adjunct Clinical Instructor

Michael Marks, MD
Professor

Tarik Massoud, MD, PhD
Professor

Lex Mitchell, MD
Adjunct Clinical Instructor

Christopher Neal, MD
Adjunct Clinical Assistant Professor

Rajul Pandit, MBBS
Clinical Assistant Professor (Affiliated)

Mrudula Penta, MD
Clinical Instructor

Neil Thakur, MD
Adjunct Clinical Instructor

Vikas Vij, MD
Adjunct Clinical Assistant Professor

Max Wintermark, MD, MBA
Professor

Kristen Yeom, MD
Associate Professor

Greg Zaharchuk, MD, PhD
Associate Professor

Michael Zeineh, MD, PhD
Assistant Professor

Nuclear Medicine and Molecular Imaging

Guido Davidzon, MD
Clinical Assistant Professor

Andrei Iagaru, MD
Associate Professor

Erik Mittra, MD, PhD
Clinical Associate Professor

Shyam Srinivas, MD, PhD
Clinical Instructor

Jeffrey Tseng, MD
Clinical Assistant Professor (Affiliated)

Thomas Yohannan, MD
Clinical Instructor

Pediatric Imaging

Patrick Barnes, MD
Professor

Richard Barth, MD
Professor

Francis Blankenberg, MD
Associate Professor

Jana Chalouhi MD
Adjunct Lecturer

Frandics Chan, MD, PhD
Associate Professor

Joseph Cheng, PhD
Instructor

Jeremy Dahl, PhD
Assistant Professor

Hisham Dahmoush, MBBCh
Clinical Instructor

Heike Daldrup-Link, MD
Professor

Safwan Halabi, MD
Clinical Assistant Professor

Diego Jaramillo, MD
Adjunct Clinical Professor

Robert Jones, MD
Adjunct Clinical Instructor

Ralph Lachman, MD
Clinical Professor

Fred Laningham, MD
Clinical Assistant Professor

David B. Larson, MD
Associate Professor

Edward Lebowitz, MD
Clinical Professor

Matthew Lungren, MD
Assistant Professor

Beverley Newman, MBBCh
Professor

Alex Oshmyansky, MD, PhD
Adjunct Lecturer

Erika Rubesova, MD
Clinical Associate Professor

Matthew Schmitz, MD
Adjunct Clinical Instructor

Jayne Seekins, DO
Clinical Assistant Professor

Glen Seidel, MD
Clinical Professor

Avnesh Thakor, MD, PhD
Assistant Professor

Shreyas Vasanawala, MD, PhD
Associate Professor

Kristen Yeom, MD
Associate Professor

Evan Zucker, MD
Clinical Assistant Professor

Radiological Sciences Laboratory (RSL)

Audrey Fan, PhD
Instructor

Gary Glover, PhD
Professor

Brian Hargreaves, PhD
Associate Professor

Feliks Kogan, PhD
Instructor

Marc Levenston, PhD*
Associate Professor

Jennifer McNab, PhD
Assistant Professor

Michael Moseley, PhD
Professor

Kim Butts Pauly, PhD
Professor

Norbert Pelc, ScD
Professor

Allan Reiss, MD
Professor

Brian Rutt, PhD
Professor

Daniel Spielman, PhD
Professor

Thoracic Imaging

Henry Guo, MD, PhD
Clinical Assistant Professor

Ann Leung, MD
Professor

Margaret Lin, MD
Adjunct Clinical Assistant Professor

Emily Tsai, MD
Clinical Instructor

VA Radiology

Stephanie Chang, MD
Clinical Instructor (Affiliated)

Bao Do, MD
Clinical Assistant Professor (Affiliated)

Christine Ghatan, MD
Clinical Instructor (Affiliated)

Charles Lau, MD, MBA
Clinical Associate Professor (Affiliated)

Patrick Lee, MD
Adjunct Clinical Assistant Professor

Sachin Malik, MD
Clinical Instructor (Affiliated)

Payam Massaband, MD
Clinical Assistant Professor

Michelle Nguyen, MD
Clinical Assistant Professor (Affiliated)

Eric Olcott, MD
Professor

Christopher Parham, MD, PhD
Clinical Instructor (Affiliated)

Amanda Rigas, MD
Clinical Instructor (Affiliated)

Rajesh Shah, MD
Clinical Assistant Professor (Affiliated)

Lewis Shin, MD
Clinical Associate Professor (Affiliated)

Ali Tahvildari, MD
Clinical Assistant Professor (Affiliated)

Katherine To'o, MD
Clinical Assistant Professor (Affiliated)

Eric Tranvinh, MD
Clinical Instructor

VA Nuclear Medicine

Christine Keeling, MBBS
Clinical Associate Professor (Affiliated)

George Segall, MD
Professor

Minal Vasanawala, MBBS
Clinical Assistant Professor (Affiliated)

* Courtesy Appointment

New Faculty Appointments (2016–2017)

Raag Airan, MD, PhD

Assistant Professor
Neuroimaging

Dr. Raag Airan received his BS in physics and mathematics from MIT (2003). From Stanford, he received an MS (2006), MD (2010), and a PhD in bioengineering (2010). Dr. Airan completed an internship at Washington Hospital Center in Washington, DC (2011), followed by a radiology residency (2011–2015) and neuroradiology fellowship (2016) at Johns Hopkins. He joined Stanford Radiology as an Assistant Professor (2016). Dr. Airan's primary research interests focus primarily on the development and use of MR-guided focused ultrasound (MRgFUS) for interventions in the nervous system.

Benedict Anchang, PhD

Instructor
Integrative Biomedical Imaging Informatics (IBIIS)

Dr. Anchang received his BS in mathematics from the University of Buea, Cameroon (2002). He then earned two MS degrees in statistics and in applied statistics, both from the University of Hasselt, Belgium (2005–2006). He next completed his PhD in bioinformatics, magna cum laude, from the University of Regensburg, Germany (2011). He joined the Integrative Biomedical Imaging Informatics at Stanford (IBIIS) Division as a postdoctoral fellow (2012). Dr. Anchang continues his research with IBIIS in mathematical modeling, disease progression, and prediction. He was appointed as a Radiology Instructor in 2017.

Stephanie Chang, MD

Clinical Instructor (Affiliated)
Body MRI

Dr. Stephanie Chang received her MD from UCSF in 2010, and completed her Internal Medicine internship at Kaiser Permanente in Oakland from 2010 to 2011. She began her diagnostic radiology residency at Washington University in St. Louis in 2011 and transferred to our residency program the following year. She completed a fellowship in our Body MRI division in 2016 and joined VA Palo Alto as a Staff Radiologist.

Joshua Cates, PhD

Instructor
Molecular Imaging Program at Stanford (MIPS)

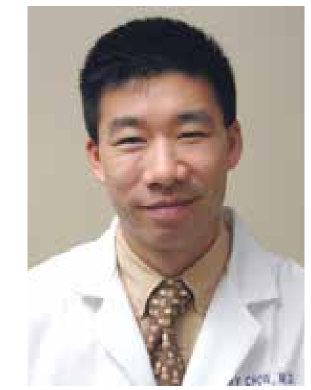
Dr. Cates received his PhD in Nuclear Engineering from the University of Tennessee in 2013. He has been a postdoctoral fellow in our Department since 2013 in Dr. Craig Levin's lab. He has been involved in several molecular imaging instrumentation research projects, including the research, development and testing of a prototype PET system. He has also helped direct the Basic Sciences Lecture series for Nuclear Medicine and Radiology residents. He was the recipient of the IEEE Trainee Award in 2008, 2014, 2015, and the Valentin T. Jordanov Radiation Instrumentation Award in 2014, 2015, and 2016.

Joseph Cheng, PhD

Instructor
Pediatric Radiology

Dr. Cheng received his BS degree at MIT (2006) and also his Masters in Engineering (2007). He then completed his PhD in electrical engineering, at Stanford (2013). He continued as a postdoctoral scholar in radiology (2013–2016), where he is well-known as an expert in free-breathing MRI and other techniques that benefit clinical pediatric patients. Dr. Cheng was named a WS Moore Young Investigator, ISMRM (2015). Continuing his work on the development of novel translational pediatric MRI techniques, Dr. Cheng was appointed as a Radiology instructor in 2016.

Lawrence Chow, MD



Clinical Associate Professor
Body Imaging

Dr. Chow earned his MD from the University of Michigan (1995) and completed an internship at the University of Vermont (1996). He completed his radiology residency (2000) and a body imaging fellowship (2001), both at Stanford Radiology. He was an Assistant Professor in our department (2002–2005). He then became Associate Professor of Radiology at the Oregon Health and Science University (OHSU) (2005–2011). He has worked as a consulting radiologist for Vision Radiology Professional Services since 2005 and as a radiologist for OHSU since 2011. Dr. Chow recently returned to Stanford as Clinical Associate Professor in Body Imaging in 2017.

Hisham Dahmoush, MBBCh

Clinical Instructor
Neuroimaging

Dr. Dahmoush received his MBBCh degree from Cairo University (1996) and completed his internship and radiology residency at Cairo University Hospitals (2001). He was faculty at the latter and at Wadi El Neel Hospital (2002–2010). He then completed a pediatric neuroradiology fellowship at Children's Hospital of Philadelphia (CHOP) (2012), a pediatric radiology fellowship at CHOP (2013), and an adult neuroradiology fellowship at the Hospital of the University of Pennsylvania (2014). He returned to CHOP for a child neurology fellowship (2015) and a one-year internal medicine residency at the Brigham and Women's Hospital in Boston before joining our department in 2016.

Guido Davidzon, MD

Clinical Assistant Professor
Nuclear Medicine

Dr. Davidzon earned his MD degree from Universidad Maimónides in Buenos Aires, Argentina (2003) and completed a two-year neurology research fellowship at Columbia University (2006), and a surgical internship at Yale New Haven Hospital (2007). He also completed an NLM Fellowship in biomedical informatics at Harvard-MGH (2010). He completed Stanford Radiology's three-year residency program in nuclear medicine and molecular imaging (2013) and was Chief Resident during his third year. He practiced as a nuclear medicine physician at Kaiser Permanente, Santa Clara, and was Clinical Assistant Professor at Boston University before joining our department in 2017.

New Faculty Appointments (2016–2017)

Joseph DeMartini, MD

Clinical Associate Professor
Musculoskeletal Imaging

Dr. Joseph DeMartini received his BS, with honors, from UC Davis (1980). After completing his Master's degree in civil engineering from California State University, Sacramento (1984), he completed his MD at the Medical College of Virginia (1997). Following completion of a radiology residency at the University of Washington (2002), he completed a fellowship in musculoskeletal radiology at the Mayo Clinic (2003). Dr. DeMartini was an Associate Professor at the University of Wisconsin-Madison (2013–2016) prior to joining our department as a Clinical Associate Professor in 2016.

Wendy DeMartini, MD

Professor
Breast Imaging

Dr. DeMartini received her BS from Saint Mary's College of California (1993) and an MD from Medical College of Virginia (1997). She completed her residency at the University of Washington (UW) (2002), a fellowship at Barrow Neurological Institute (2003), and a breast imaging fellowship at UW (2004). From 2004–2011, she was faculty at UW and was recruited to the University of Wisconsin as Professor of Radiology and Section Chief of Breast Imaging (2013). Dr. DeMartini was elected President of SBI (2017). She joined our department as Professor of Radiology and Division Chief of Breast Imaging in 2016.

Ahmed El Kaffas, PhD

Instructor
Body Imaging

Dr. El Kaffas received his BS (2005) and his MS degrees both from Ryerson University in Toronto, Canada (2008). He received his PhD in medical biophysics from the University of Toronto (2013) and was a postdoctoral fellow at the Sunnybrook Research Institute and the University of Toronto (2014). Continuing his research in ultrasound, Dr. El Kaffas joined the Stanford Radiology as a postdoctoral scholar (2015). As a member of the Body Imaging Division and participant in its ultrasound-related research activities, Dr. El Kaffas was recently appointed Instructor in 2017.

Christine Ghatan, MD

Clinical Instructor (Affiliated)
Interventional Radiology

Dr. Christina Ghatan received her MD from USC (2009). She completed her residency in Diagnostic Radiology at Cedars-Sinai Medical Center (2014), followed by an Interventional Radiology fellowship at Icahn School of Medicine at Mount Sinai (2015). Prior to joining VA Palo Alto as a staff radiologist, she was an Assistant Professor at the University of Colorado Denver. She joined our department as a clinical instructor in 2017.

Stefan Harmsen, PhD

Instructor
Molecular Imaging
Program at Stanford (MIPS)

Dr. Harmsen completed his MS in chemistry at Free University, Amsterdam (2005), and his PhD in toxicology (2009) and postdoctoral research fellowship (2010) at Utrecht University, Netherlands. He worked as a Research Fellow and then was a Research Associate at the Memorial Sloan Kettering Cancer Center, New York (2014–2016). His research involves the design, synthesis, and characterization of nanoparticles and dyes for early detection of cancer, immune cell monitoring, and guided resection. Most recently, Dr. Harmsen joined Stanford's Department of Pediatrics, Division of Neonatology, and then transitioned to our department as an Instructor in 2017.

Syed Hashmi, MD

Clinical Instructor
Neuroimaging

Dr. Hashmi received his MD from the University Of Illinois College Of Medicine at Urbana-Champaign (2011). Following his medical training, he completed a one-year internship at the University of Texas Health Science Center at Houston (UTHealth) (2012). He continued on at UTHealth to complete his radiology residency training (2016). Following his residency, Dr. Hashmi also completed a fellowship at Barrow Neurological Institute in Phoenix, Arizona before joining our department as a Clinical Instructor in 2017.

Sharon Hori, PhD

Instructor
Molecular Imaging
Program at Stanford (MIPS)

Dr. Hori received her BS in applied mathematics and a second BS in cybernetics, both from UCLA (2003). Continuing at UCLA, Dr. Hori also earned an MS in biomedical engineering (2007). She was a postdoctoral fellow in our Department from 2008–2014, and then moved into a Research Associate role. Her research on developing cancer animal models to study early-stage disease overlaps with research efforts of the Molecular Imaging Program at Stanford (MIPS) and the Canary Center for Cancer Early Detection (Canary). Dr. Hori was appointed Instructor of Radiology in 2016.

Ibrahim Idakoji, MD

Clinical Instructor
Interventional Radiology

Dr. Idakoji received an MPH degree from Boston University School of Public Health (2007). Following this, he received his MD from Northwestern University (2011) and completed an internship year, also at Northwestern University (2012). He then joined Stanford Radiology to complete his diagnostic radiology residency (2016). Following residency training, Dr. Idakoji completed a fellowship in vascular and interventional radiology, also here at Stanford (2017). Dr. Idakoji, who brings his extensive knowledge and finely honed skills to our Interventional Radiology clinical division, was appointed Clinical Instructor following his fellowship training in 2017.

New Faculty Appointments (2016–2017)

Andrew Kesselman, MD

Clinical Instructor
Interventional Radiology

Dr. Kesselman received his MD from New York Medical College (2011) followed by a one-year internship at Mount Sinai Beth Israel Medical Center, New York. He then completed a diagnostic radiology residency program at the State University of New York (2016). Following his residency, he completed a vascular and interventional radiology fellowship in our department (2017), and Dr. Kesselman specializes in minimally invasive image-guided procedures and comprehensive management of vascular and oncologic disease. He was appointed as a Clinical Instructor for the Interventional Radiology Division in 2017.

Feliks Kogan, PhD

Instructor
Radiological Sciences Laboratory (RSL)

Dr. Kogan received his BS in optics and applied mathematics from the University of Rochester (2007), following with his PhD in bioengineering from the University of Pennsylvania (2013). He completed an MRI postdoctoral fellowship in the Radiological Sciences Lab (RSL) (2015), and continued on as a Research Associate (2015–2017). He was named an ISMRM Junior Fellow (2015), honored with an ISMRM Young Investigator Cum Laude Award (2017), and received an NIH/NIBIB K99 award (2017). Dr. Kogan was appointed Instructor in 2017.

Shivaani Kummar, MD

Professor
Molecular Imaging Program at Stanford (MIPS)

Dr. Kummar is Professor of Medicine (Oncology) and of Radiology (Molecular Imaging Program at Stanford (MIPS)(Secondary Appointment in Radiology). She completed her MD at the Lady Hardinge Medical College (New Delhi, India) (1992). Her training in clinical trials at the National Institutes of Health (NIH) introduces valuable collaboration potential with faculty in the design of new cancer clinical trials, with consideration for the best imaging modalities to optimize the trial. She works closely with our faculty to understand how specific cancer clinical trials may benefit patients. Dr. Kummar was appointed Professor of Medicine and Radiology in 2016.

Bryan Lanzman, MD

Clinical Instructor
Neuroimaging

Dr. Lanzman received his MD from Columbia University (2010) College of Physicians and Surgeons. He then completed his residency in diagnostic radiology at New York-Presbyterian Hospital, Columbia University Medical Center (2015). Dr. Lanzman was a fellow in the Neuroimaging and Neurointervention division and was appointed Clinical Instructor in 2017.

Edward Lo, MD

Clinical Instructor
Body Imaging

Dr. Lo received his MD from the University of Illinois at Chicago (2010), followed by a one-year internship at Weiss Memorial Hospital, Illinois (2011). He then completed his diagnostic radiology residency at the University of Illinois at Chicago (2015). Dr. Lo then came to the Stanford Department of Radiology as a concurrent fellow and Clinical Instructor (2015–2016). He was appointed as a Clinical Instructor in our Body Imaging Division in 2016.

Ying Lu, PhD

Professor (Courtesy)
Molecular Imaging Program at Stanford (MIPS)

Dr. Lu is Professor of Biomedical Data Science and, by courtesy, of Radiology (Molecular Imaging Program at Stanford (MIPS)) and of Health Research and Policy (Epidemiology). He collaborates with our faculty and provides statistical expertise on study design and analysis. He is also involved in statistical methodology research in radiology, in particular on topics of imaging clinical trial design, quality control and validation of imaging markers, and statistical decision-making for choosing imaging modalities. Dr. Lu was appointed Professor of Radiology (courtesy) in 2017.

Sachin Malik, MD

Clinical Instructor (Affiliated)
Thoracic Imaging

Dr. Sachin Malik received his MD degree from Case Western Reserve University School of Medicine (2010). He completed his internship in Medicine (2011) and his residency in Diagnostic Radiology (2015), both at Kaiser Permanente Los Angeles Medical Center, completing a 12-month MRI Mini-Fellowship as part of his training. Prior to joining VA Palo Alto as a staff radiologist, he was a Cardiothoracic Imaging fellow at Duke University. At VA Palo Alto, he covers both Thoracic and Cardiovascular Imaging. Dr. Malik was appointed Clinical Instructor in 2016.

Sanjay Malhotra, PhD

Associate Professor
Molecular Imaging Program at Stanford (MIPS)

Dr. Malhotra is Associate Professor of Radiation Oncology (Radiation and Cancer Biology) and Radiology (Molecular Imaging Program at Stanford (MIPS) Division) (Secondary Appointment in Radiology). Dr. Malhotra, who received his PhD in Chemistry in 1993, provides scientific guidance to our MIPS faculty with respect to medicinal chemistry. He helps design and optimize small molecules for use in imaging for translational medicine. He will also work with new molecular targets to identify new leads against those specific targets.

New Faculty Appointments (2016–2017)

Michael Muelly, MD

Clinical Instructor
Body MRI

Dr. Michael Muelly received his MD from Penn State University (2011). He completed one year of Preliminary Surgery residency at Penn State Hershey Medical Center (2012). He transferred to Stanford as a Diagnostic Radiology resident in our Department (2012–2016), and completed his fellowship in Body MRI in our Department in 2017. He will be at Stanford one day per week providing clinical care in Body MRI. His primary position is at Google where he will be a Brain Resident, working on research application of Google's deep learning techniques to healthcare.

Koen Nieman, MD, PhD

Associate Professor
Cardiovascular Imaging

Dr. Nieman is Associate Professor of Medicine (Cardiovascular Medicine) and of Radiology (Cardiovascular Imaging) (Secondary Appointment in Radiology). He received his MD from Radboud University in the Netherlands (1998) and his PhD in coronary CT angiography from Erasmus University Medical Center (Erasmus MC), Rotterdam (2003). He completed his cardiology training in Rotterdam (2008). Dr. Nieman is an internationally recognized expert in cardiac CT and coronary CT angiography. Dr. Nieman was Associate Professor and Director of the Cardiac CT and MR Research Program at Erasmus MC before joining our department in 2016.

Christopher Parham, MD, PhD

Clinical Instructor (Affiliated)
Body MRI

Dr. Christopher Parham received his MD and PhD from the University of North Carolina (UNC) Chapel Hill (2006). He did his postdoctoral fellowship in Biomedical Engineering (2006–2007) at UNC. He began his residency at UCSF in the Department of Radiology and Biomedical Imaging in 2008 and transferred to the Radiology residency program at UNC Chapel Hill (2009–2012). Dr. Parham completed an NCI Body Imaging fellowship in our Department in 2013. He has been working as a radiologist at VA Palo Alto since 2012. Dr. Parham was appointed Clinical Instructor in 2017.

Bhavik Patel, MD, MBA

Assistant Professor
Body Imaging

Dr. Patel received his BS (2003) and MD (2007) from the University of Alabama (UAB). He also completed his diagnostic radiology residency training at UAB, where he served as Chief Resident (2011–2012). He completed a body imaging fellowship at Stanford (2012), after which, he joined Duke as faculty (2013). He additionally received his MBA from the UCLA Anderson School of Management (2015). His research includes novel imaging methods, disease monitoring, and healthcare economics. Dr. Patel joined Radiology as an Assistant Professor in the Body Imaging Division in 2017.

Mrudula Penta, MD

Clinical Instructor
Neuroimaging

Dr. Penta received her BA, magna cum laude, from Rice University (2002) and her MD from Stanford School of Medicine (2006). She completed an otolaryngology-head and neck surgery residency at Washington University in St. Louis (2010), followed by a diagnostic radiology residency at the University of Texas Southwestern Medical Center (2014). She joined Stanford Radiology as a neuroradiology fellow (2014–2016) and concurrently was appointed Clinical Instructor in 2016.

Sheena Prakash, MD

Clinical Instructor
Body Imaging

Dr. Prakash received her MD (2010) from Louisiana State University (LSU) School of Medicine in Shreveport. She completed her residency in diagnostic radiology at Wake Forest Baptist Medical Center (2015). She completed an abdominal imaging fellowship at Stanford Radiology (2016) before being appointed in our department as a Clinical Instructor in 2017.

Johannes Reiter, PhD

Instructor
Canary Center

Dr. Reiter received his PhD (2015) from the Institute of Science and Technology Austria (IST Austria). Shortly after, he worked at the Broad Institute and the Dana-Farber Cancer Institute in Cambridge, MA. He was a postdoctoral researcher at Harvard University, prior to joining our Department (2017). His new approach to reconstruct the evolutionary history of metastases has been shown to significantly outperform existing methods and is already used in multiple research institutions. He was appointed Instructor in 2017.

Stephan Rogalla, MD

Instructor
Molecular Imaging
Program at Stanford (MIPS)

Dr. Rogalla received his MD from Humboldt University of Berlin, in Germany (2006). He completed his residency in gastroenterology, oncology, and surgery from Charité Medical University of Berlin, in Germany (2012). He completed a postdoctoral fellowship in our department (2015). He will continue his research to improve the diagnostics and treatment of medulloblastoma. Dr. Rogalla transitioned from the Department of Pediatrics to Radiology as an Instructor in 2017.

New Faculty Appointments (2016–2017)

Taiyo Shimizu, MD

Clinical Assistant Professor
Interventional Radiology

Dr. Shimizu earned his MD from UCLA (2008), followed by an internship (2009). He completed his radiology residency at Mount Sinai Medical Center, Miami, where he was Chief Resident (2013). He also completed a vascular and interventional radiology (IR) fellowship at NYU as Chief Fellow (2014). Dr. Shimizu worked as an interventional radiologist at Sutter Health in Modesto (2014–2017). With significant experience building an IR service, Dr. Shimizu will lead IR and Breast Imaging faculty as Director of ValleyCare and Emeryville Radiology Services. He will be responsible for scheduling, strategy, practice growth, and community outreach. He was appointed Clinical Assistant Professor in 2017.

Andrew Shon, MD

Clinical Instructor
Body Imaging

Dr. Shon received his MD from the University of Illinois at Chicago (2011). He completed a diagnostic radiology residency at the University of Illinois at Chicago (2016). Following his residency, Dr. Shon completed a body imaging fellowship at Stanford Radiology (2017). Following his postdoctoral training, he became a full-time Clinical Instructor in our Department in 2017.

Emily Tsai, MD

Clinical Instructor
Thoracic Imaging

Dr. Tsai received her MD from Stanford University (2011). She completed her radiology residency at UCLA (2016), followed by a thoracic imaging fellowship, as Chief Fellow, at UCLA (2017). Her research interest is in PET staging of lung cancer and CT-guided lung biopsy. Dr. Tsai joined Stanford Radiology as a Clinical Instructor in thoracic imaging in 2017.

Katheryne Wilson, PhD

Instructor
Molecular Imaging
Program at Stanford (MIPS)

Dr. Wilson received her PhD from the University of Texas in 2012. She has been a Postdoctoral Fellow in our Department since 2012 and is currently working closely with Dr. Juergen Willmann. In her new role as Instructor, she will be expanding the research program on photoacoustic imaging and machine learning in the Translational Molecular Imaging laboratory and teaching graduate students, medical students, residents and fellows. She is the recipient of several awards, including an NIH K99, a Molecular Imaging Young Investigator Award from Stanford, and a Helena Anna Henzl-Gabor Young Women in Science Travel Fellowship.

Xin Ye, MD

Clinical Instructor
Breast Imaging

Dr. Ye received his MD from UCLA (2011). He completed a preliminary medicine internship at the White Memorial Medical Center (WMMC) in Los Angeles (2012). He then completed radiology residencies at Emory University (2013) and Loma Linda University (2016) respectively, both prior to the completion of a breast imaging fellowship (2017). Dr. Ye provides all aspects of clinical breast imaging and general radiology services. He joined the department as a Clinical Instructor in 2017.

Thomas Yohannan, MD

Clincal Instructor
Nuclear Medicine

Dr. Yohannan received his MD from the University of Illinois (2011). He completed his residency at the Aurora St. Luke's Medical Center in Milwaukee, WI (2016). Following his residency, Dr. Yohannan became a Clinical Fellow at UCSF's Department of Nuclear Medicine, where he participates in clinical care and teaching. His interests as a new faculty member at Stanford include clinical care and teaching. He was appointed Clinical Instructor in 2017.

Evan Zucker, MD

Clinical Assistant Professor
Pediatric Radiology

Dr. Zucker received his MD from Harvard Medical School (2008) after which he completed a one-year internship at Newton-Wellesley Hospital in Newton, MA (2009). He completed his residency in diagnostic radiology at Tufts Medical Center, Boston (2013) and a fellowship in pediatric radiology at the Stanford Lucile Packard Children's Hospital (2014). He joined our faculty as a Clinical Instructor (2014) but soon thereafter left for a cardiovascular imaging fellowship at MGH. Dr. Zucker then returned to Stanford in a new role as Clinical Assistant Faculty in 2016.

New Adjunct Appointments (2016–2017)

Quazi Al-Tariq, MD
Adjunct Clinical Instructor
Body Imaging

Jana Chalouhi, MD
Adjunct Lecturer
Pediatric Radiology

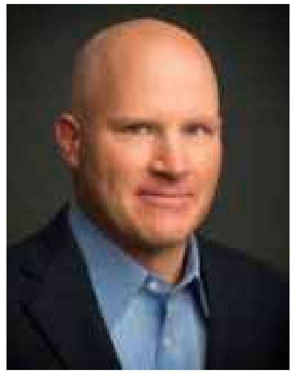
Wilson Chwang, MD, PhD
Adjunct Clinical Instructor
Neuroimaging

David Douglas, MD
Adjunct Clinical Instructor
Neuroimaging

Sanjay Gupta, MD
Adjunct Clinical Instructor
Cardiovascular Imaging

Diego Jaramillo, MD
Adjunct Clinical Professor
Pediatric Radiology

Robert Jones, MD
Adjunct Clinical Instructor
Pediatric Radiology



Jeff Kleck, PhD
Adjunct Professor
Molecular Imaging Program at Stanford

Patrick Lee, MD
Adjunct Clinical Assistant Professor
Musculoskeletal Imaging
VA Palo Alto Health Care System

Connie Montgomery, MD
Adjunct Clinical Instructor
Musculoskeletal Imaging

Alex Oshmyansky, MD, PhD
Adjunct Lecturer
Pediatric Radiology

Neil Thakur, MD
Adjunct Clinical Instructor
Neuroimaging

Faculty Retirements (2016–2017)

Peter Kane, MD
Years of Service 1999–2016

Dr. Peter Kane received his BS from Santa Clara University and his MD from Saint Louis University. He completed his residency training at St. Mary's Hospital in San Francisco (1965) and was the resident supervisor at Los Angeles County General Hospital (1965–1966).

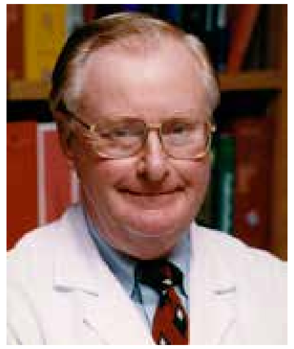
Following his medical school and residency training, Dr. Kane launched his career as a pediatric radiologist at Oakland Children's Hospital, where he served in this role from 1967 to 2002. Intermittently, Dr. Kane set aside time for reservist military service during 1960–1962 and as a radiologist at US Army Hospitals during 1990 and 1991. During these years, he also held appointments at UCSF and UC Davis and served as President of the Pacific Coast Pediatric Radiologists Association. Following his military service and work at Oakland Children's Hospital, Dr. Kane joined the Stanford Lucile Packard Children's Hospital as a Clinical Professor in October 1999, where he became an active member of the faculty and a friend and colleague to many. Dr. Kane tried to retire in 2013, but Dr. Rich Barth gently coaxed him to stay on as faculty "just a bit longer." In December 2016, after a career filled with compassion for his patients and generous service to his country, Dr. Kane officially retired with fond memories and true friendships made during his 17 years of service to Stanford and the Lucile Packard Children's Hospital.

Peter Moskowitz, MD
Years of Service 1975–1982 and 2001–2016

Dr. Peter Moskowitz completed medical school training at UCSF in 1970, an internship in medicine/pediatrics at the University of Wisconsin in 1971, radiology residency training at UCSF in 1974, and a senior residency in pediatric radiology at the Children's Hospital in Boston in 1975. Dr. Moskowitz spent much of his radiology career in the Bay Area including UCSF, Stanford, and LPCH. He has been a member of the Stanford Radiology family for 22 years as Clinical Professor of Pediatric Radiology.

Dr. Moskowitz received Emeritus status in 2013, and worked part-time until July 2016. He remains dedicated to his other passion, guiding doctors through career transitions and burnout, as a certified career transition and life coach since 1997. He is a member of the American Counseling Association and the New Edges Learning Community. He recently co-authored a book on physician career management titled, *The Three Stages of a Physician's Career: Navigating from Training to Beyond Retirement*. More information about Dr. Moskowitz and his work as a physician coach is available at http://cppr.com. We thank Dr. Moskowitz for his many years of service, his passion and support of his colleagues, and his dedication to further the field of radiology and the empowerment of its physicians.

Iain Ross McDougall, MD, PhD
Years of Service 1976–2008 and 2009–2016



Dr. Ross McDougall retired in January 2016 after 40 years of service. He has been associated with Stanford University Hospitals and the School of Medicine since 1972, first as a fellow for two years, and from 1976 to 2008 as full-time faculty. He was born, raised, and educated in Glasgow, Scotland where he attended the University of Glasgow to study medicine. Dr. McDougall trained in medicine and passed the Membership Examination of the Royal College of Physicians and Surgeons in Glasgow in 1971 and subsequently became a Fellow of that College and the Royal College of Physicians in London. He was awarded a PhD in 1972 for clinical and radiobiological studies of Iodine-125 for the treatment of thyrotoxicosis. In 1972, he received a Harkness Fellowship to spend 21 months conducting thyroid research at Stanford under the supervision of the late Dr. Joseph Kriss from 1972–1974. He then returned to Glasgow in 1974.

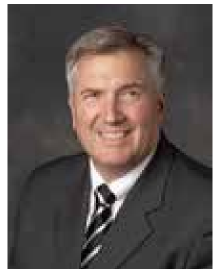
Following a brief stay in his home country, Dr. McDougall was lured back to Stanford in 1976 as an Associate Professor in Nuclear Medicine but also attended on the Internal Medicine and Endocrinology wards. Due to his work and earlier training, in 1989 he was appointed director of the Kriss thyroid clinic, which he led for 20 years. He also became director of the Nuclear Medicine Residency Program, which he led for 25 years. In recognition of his clinical and teaching abilities, he was awarded the Arthur Bloomfield Award for excellence in teaching of clinical medicine in 1985, the Alwin C. Rambar Award for clinical excellence in 1988, and the Albion Walter Hewlett Award in 2010. For his work in thyroid cancer, Dr. McDougall received the Distinguished Scientist Award from the Western Regional Chapter of the Society of Nuclear Medicine and Molecular Imaging in 2006.

Dr. Ross McDougall served Stanford on multiple fronts as Chairman of the Medical School Senate and President of the Medical Center. He was appointed to the American Board of Nuclear Medicine where he served as Chairman (2 years) and Governor of the American Board of Internal Medicine (3 years). Dr. McDougall has inspired generations of physicians, technologists, and trainees to be the very best they can be. We have enjoyed working with and alongside this most amazing, and dedicated clinician.

Faculty Departures (2016–2017)

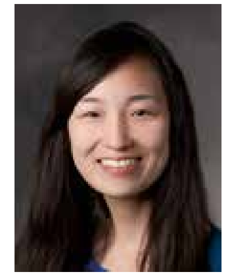

Roland Bammer, PhD
Associate Professor
RSL/Pediatric Radiology


Joan Cheng, MD
Clinical Instructor
Body Imaging


Christopher Contag, PhD
Professor
Department of Pediatrics (courtesy in Radiology (MIPS))

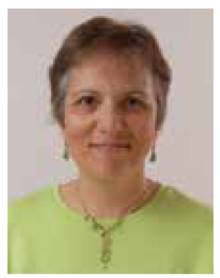

Scott Hsieh, PhD
Instructor
RSL


Stefan Hura, MD
Clinical Instructor
MSK


Christine Kim, MD
Clinical Instructor
Neuroimaging


Sri Kothapalli, PhD
Instructor
MIPS


Kerstin Mueller, PhD
Instructor
RSL


Zina Payman, MD
Clinical Assistant Professor
Neuroimaging


Andrew Quon, MD
Associate Professor and Co-Division Chief
Nuclear Medicine


William Thomas, MD
Clinical Instructor
Breast Imaging


Johnny Wong, MBBS, PhD
Clinical Instructor
Neurointervention

Adjunct, Affiliated, and Consulting Faculty Departures (2016–2017)

Amy Asandra, MD
Adjunct Clinical Instructor
Interventional Radiology

Bryan Chan, MD
Adjunct Clinical Instructor
Musculoskeletal Imaging

Lawrence Cheung, MD
Adjunct Clinical Instructor
Body Imaging

Anne Chin, MD
Adjunct Clinical Assistant Professor
Cardiovascular Imaging

Veronica Cox, MD
Adjunct Clinical Instructor
Body Imaging

Steven Deso, MD
Adjunct Clinical Instructor
Interventional Radiology

Riaz Dhanani, MD
Adjunct Clinical Instructor
Interventional Radiology

Anthony Filly, MD
Adjunct Clinical Assistant Professor
Body Imaging

Arundhuti Ganguly, PhD
Consulting Assistant Professor
Radiological Sciences Lab

Jennifer Kao, MD
Clinical Associate Professor (Affiliated)
Breast Imaging

Jayanth Keshavamurthy, MBBS
Adjunct Clinical Instructor
Cardiovascular Imaging

Shoo Ming Lee, PhD
Consulting Assistant Professor
Radiological Sciences Lab

Marcia McCowin, MD
Adjunct Clinical Associate Professor
Thoracic Imaging

Joseph McGinley, MD PhD
Adjunct Clinical Instructor
Cardiovascular Imaging and Musculoskeletal Imaging

Aaron Potnick, MD
Adjunct Clinical Instructor
Pediatric Radiology

David Sandman, MD
Adjunct Clinical Assistant Professor
Musculoskeletal Imaging (VAPAHCS)

Sophia Symko, MD
Adjunct Clinical Assistant Professor
Neuroimaging

Christopher Takehana, MD
Clinical Instructor (Affiliated)
Interventional Radiology

Cam Tran, MD
Adjunct Clinical Instructor
Neuroimaging

Long Ngoc Trinh, MD
Clinical Instructor (Affiliated)
Breast Imaging

Ashwini Zenooz, MD
Clinical Assistant Professor (Affiliated)
Body Imaging (VAPAHCS)

Feature

52in52: *Completing 52 Projects in 52 Weeks*

The 52in52 initiative is an accountability framework with the goal of supporting daily problem-solving and completing 52 front-line driven projects in 52 weeks. The program was created to drive continuous improvement by empowering front-line staff to identify and solve problems while providing them with the necessary resources, tools, and management support.

52in52 is directed by Dr. David Larson (Associate Professor and Associate Chair of Performance Improvement) with a management team of Jake Mickelsen (Quality Improvement Manager), Dot Cordova (Safety and Compliance Project Manager), Sandhya Kumar (Operations Project Manager), and Allison Faust (Project Coordinator).

The three crucial elements for achieving this target are:

- Provide the tools, methods, and training needed to be able to realize improvements effectively.
- Foster an environment where methods are supported, and front-line teams can lead and collaborate with administration to solve meaningful problems.
- Allow all front-line staff to become capable problem-solvers through support, coaching, and empowerment.

PROJECT CRITERIA

- Projects that can be done within the department to make an improvement and eliminate waste.
- Should be scaled towards improving our daily workflow and/ or to create a standard workflow amongst our own immediate workspace.
- Allotted maximum eight weeks for completion, with a check-in requirement once a week.

SUPPORT MATERIALS

- Staff will be provided with concrete support, coaching, and proper guidance and tools to succeed. Quality team will ensure this support.
- Project presented to administrative leaders during a weekly check-in. Directors attend to provide support and feedback.
- Problem-solving class provided to assist with application of improvement tools.

METHOD

52in52 included staff from all service modalities and all inpatient and outpatient locations. Each project was led by a self-identified individual and assisted by a coach trained in quality improvement principles. The owner was held accountable to report on project progress, results, waste eliminated, and sustain plans. A simple problem-solving guide was provided to facilitate improvement thinking. Weekly 30-minute check-in meetings were held to ensure that projects aligned with departmental priorities and that issues could be resolved. Director level attendance at these meetings was required to ensure projects aligned with departmental priorities and issues could be resolved.

RESULTS

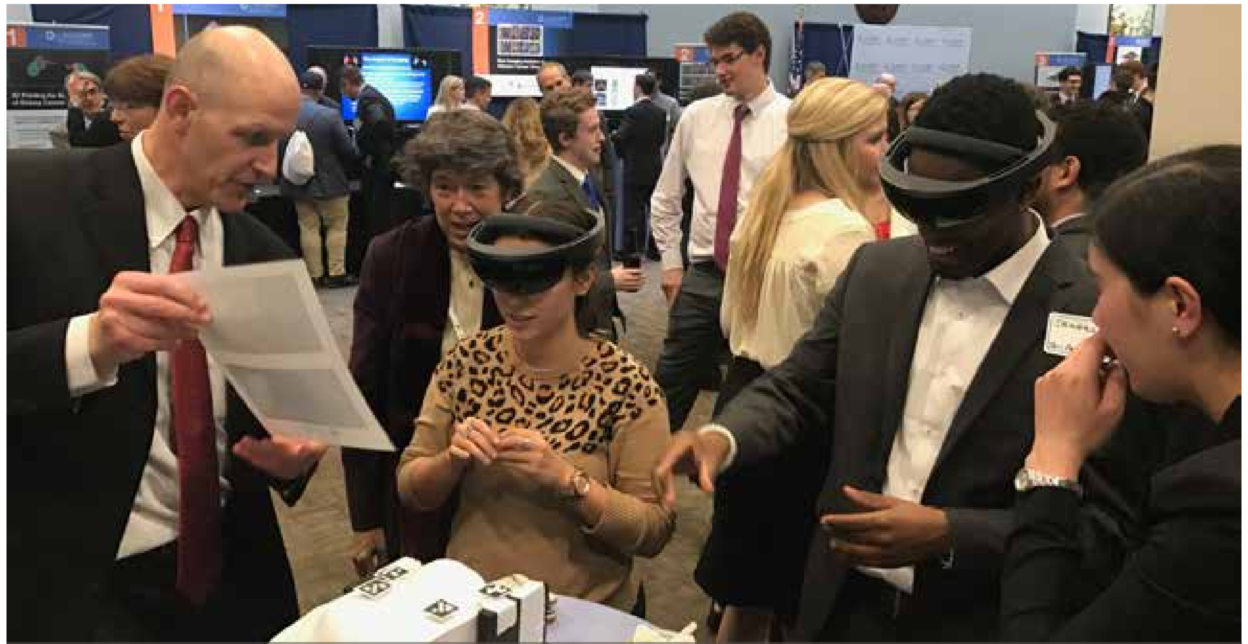
In a total of 52 weeks, 54 improvement projects were completed with an average start to completion time of 6–7 weeks. Annualized results are summarized below:

- Wasted labor time eliminated: 3,200 hours
- Labor cost savings: $280,000
- Incremental revenues: $11,400,000
- Supply cost savings: $315,000
- Patient experience top box score: +8 points at one clinic
- Near-miss safety events reduction: 60 near-miss events

Overall, employee engagement results show that 52in52 helped project leads develop in their personal growth and learning, increased their ability to contribute meaningful work to the department, and improved their knowledge and confidence to solve problems. Last, although seemingly insurmountable, completion of 52 improvement projects in 52 weeks is feasible.

Faculty Honors and Awards

Raag Airan, MD, PhD	2017 Finalist for the Science-PINS Prize for Neuromodulation
Joseph Cheng, PhD	2017 ISMRM Magna Cum Laude Merit Award
Bruce Daniel, MD	2016 Elected to AIMBE College of Fellows
Guido Davidzon, MD	2017 SNMMI Emerging Leaders Award
Wendy DeMartini, MD	2017 Elected President of the Society of Breast Imaging
Utkan Demirci, PhD	2017 Elected to AIMBE College of Fellows 2017 Academy for Radiology & Biomedical Imaging Research Distinguished Investigator Award
David Douglas, MD	2017 Ursula Mary Kocemba-Slosky, PhD, Professional Relations Fellowship
Rebecca Fahrig, PhD	2016 Elected to AIMBE College of Fellows
Michael Federle, MD	2017 Society of Computed Body Tomography and Magnetic Resonance (SCBT-MR) Gold Medal Winner
Sanjiv Sam Gambhir, MD, PhD	2016 Elected to the National Academy of Inventors 2017 Appointed President of the International Society for Strategic Studies in Radiology (IS3R)
Pejman Ghanouni, MD, PhD	2017 Honorary President of the 6th International Symposium on Focused Ultrasound
Garry Gold, MD	2016 Elected to AIMBE College of Fellows
Michelle James, PhD	2016 Suffrage Science Award, MRC Imperial College of London
Brooke Jeffrey, MD	2016 Society for Radiologists in Ultrasound Lifetime Achievement Award
Aya Kamaya, MD	2016 American Roentgen Ray Society Bronze Award
Feliks Kogan, PhD	2017 ISMRM Young Investigator Award
Curtis Langlotz, MD, PhD	2016 Named to RSNA Board of Directors
Ann Leung, MD	2016 Elected President of the Society of Thoracic Radiology (STR)
Craig Levin, PhD	2017 Elected to AIMBE College of Fellows
Matthew Lungren, MD, MPH	2017 Best Poster at The Coalition for Imaging and Bioengineering Research (CIBR) 2017 Medical Imaging Technology Showcase
I. Ross McDougall, MD, PhD	2016 SNMMI Georg Charles de Hevesy Nuclear Pioneer Award
William Northway, MD	2016 Distinguished Medical Staff Award, Lucile Packard Children's Hospital
Tomomi Nostanfoashi, MD	2017–2019 Wagner-Torizuka Fellowship
Norbert Pelc, ScD	2016 Awarded Honorary Degree by Friedrich-Alexander Universitat Erlangen-Nurnberg (FAU) 2017 Named a Fellow of SPIE, the Society of Photo-Optical Instrumentation Engineers
Sylvia K. Plevritis, PhD	2017 Selected for National Cancer Institute Board of Scientific Advisors 2017 Elected to AIMBE College of Fellows
Daniel Rubin, MD, MS	2017 Academy for Radiology & Biomedical Imaging Research Distinguished Investigator Award
George Segall, MD	2017 Peter Valk Memorial Award at SNMMI
H. Tom Soh, PhD	2017 Named Chan Zuckerberg Biohub Senior Investigator
F. Graham Sommer, MD†	2016 Academy of Radiology Research Distinguished Investigator Award
Daniel Spielman, PhD	2017 Elected to AIMBE College of Fellows 2017 Named Fellow of the ISMRM
Tanya Stoyanova, PhD	2016 McCormick-Gabilann Faculty Award
Shreyas Vasanawala, MD, PhD	2016 Academy of Radiology Research Distinguished Investigator Award
Juergen Willmann, MD	2017 Elected to AIMBE College of Fellows 2017 Academy for Radiology & Biomedical Imaging Research Distinguished Investigator Award
Joseph Wu, MD, PhD	2017 American Heart Association Merit Award
Greg Zaharchuk, MD, PhD	2016 Academy of Radiology Research Distinguished Investigator Award

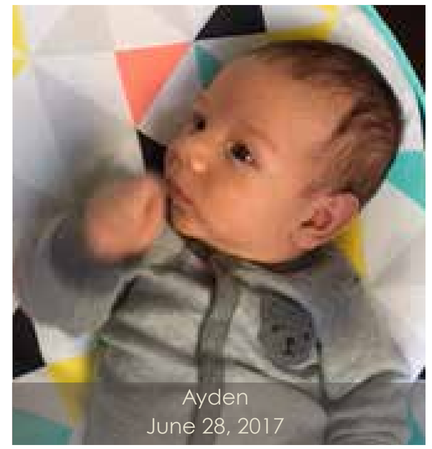


Eighth Annual Medical Imaging Technology Showcase (2017)

Future Faculty and Staff


Alexander Li Pelc (grandson)
July 27, 2017
Norbert Pelc, ScD
Professor


Skip Hency (grandson)
July 16, 2017
Bob Herfkens, MD
Professor


Ayden
June 28, 2017
Ahmed El Kaffas, PhD
Instructor

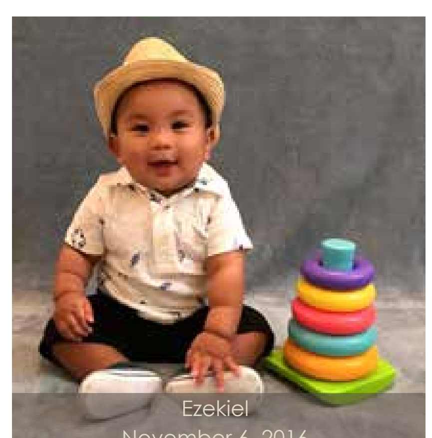

Elena Alexandra Ksoll
June 14, 2017
Tanya Stoyanova, PhD
Assistant Professor

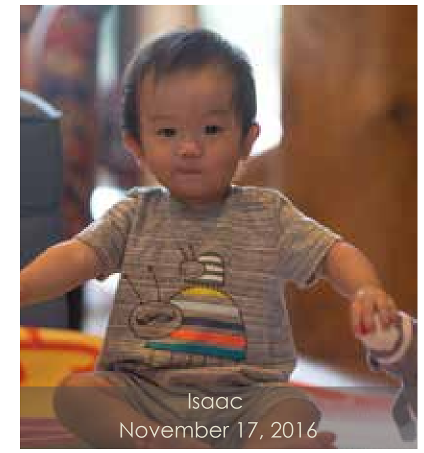

Lauren Phan
June 13, 2017
Bao Do, MD
Clinical Instructor (VAPAHCS)


Mila Veronica Rivera (granddaughter)
February 3, 2017
Eileen Misquez
Administrative Associate


Mira
January 23, 2017
Raag Airan, MD, PhD
Assistant Professor


Alice Elena Diaz (granddaughter)
December 6, 2016
John Mendoza
Facilities Manager


Ezekiel
November 6, 2016
Jessa B. Castillo
Radiochemistry Research Assistant


Isaac
November 17, 2016
Eric Tranvinh, MD
Clinical Instructor


Kamilla and Ian
September 6, 2016
Stephanie van de Ven, MD, PhD
Deputy Director (Canary Center)


Josephine
August 29, 2016
Anne Muehe, MD
Postdoctoral Fellow


Sophie Maya
August 25, 2016
Bin Shen, PhD
Manager, Cyclotron and Radiochemistry Facility

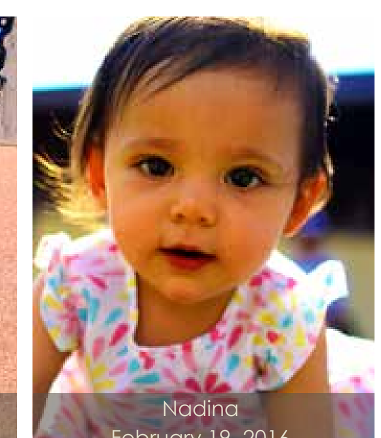

Jack
August 16, 2016
Jennifer McNab, PhD
Assistant Professor


Max M.
May 23, 2016
Jia Wang
Medical Physicist


Joseph Ram
May 1, 2016
Angela Raihman
Medical Assistant


Tim Ian
March 7, 2016
Michael Muelly, MD
Clinical Instructor


Oliver Kai
March 3, 2016
Andy Loening, MD, PhD
Radiologist


Nadina
February 19, 2016
Rajesh Shah, MD
Director, IR (VAPAHCS)


Cruz Thomas
February 12, 2016
Justin Beck
MRI Technologist

Equipment and Facilities

In recent years, we have experienced exponential growth of our clinical imaging capabilities. With the planned opening of the Lucile Packard Children's Hospital Expansion in December 2017, construction completion of the New Stanford Hospital in 2019, the newly added outpatient sites and the commitment to keeping our hospitals current, we have purchased more imaging equipment than ever before. In the last three years alone, we have acquired a staggering 15 new MRIs. Our ability to site the most cutting-edge equipment ensures that we can achieve our commitment to the highest levels of patient care.

The following is a summary of the major new sites that have been added to our enterprise in recent years, along with the upcoming openings of our new hospitals and the latest equipment installations at our adult hospital.

Expansion of Clinical Sites

Location	Equipment	Opening
Cancer Center South Bay	CT, MRI, PET-CT, 2 Digital Breast Tomosynthesis, ultrasound, X-ray	July 2015
Children's Hospital Expansion	MRI, PET-MR, MRI in operating room suite, SPECT-CT, SPECT, X-ray, 2 Interventional Radiology Angiography suites (1 Bi-Plane system, 1 Single-Plane system)	December 2017
Emeryville	MRI, CT, SPECT-CT, Digital Breast Tomosynthesis, X-ray, ultrasound, BMD, Angiography Hybrid	March 2017
New Stanford Hospital	3 MRIs, 1 MRI in OR Suite, 3 CTs X-ray, ultrasound, Angiography Equipment: 4 Single Plane systems, 3 Bi-Plane systems, 2 Hybrid systems	2019
Redwood City - Pavilion D Expansion	CT, ultrasound, X-ray, EOS	Spring 2018
Stanford Neurosciences Center	CT, MRI, PET-MR, ultrasound, X-ray/Fluoro	December 2015
Valley Care Medical Center	MRI, GI Fluoro, and Digital Breast Tomosynthesis equipment replacements in progress	April 2015

New/Upgraded Equipment in Stanford Hospital

Location	Equipment	Opening
Adult Hospital	Replaced MRT with 3T MRI	January 2017
	Siting of HIFU Head Unit for Trans Cranial MRI guided Focused Ultrasound for non-invasive neurosurgery applications in the brain	January 2017
	New Digital PET-CT	September 2016
Advanced Medicine Center	New Wide Bore MRI (shared with Radiation Oncology)	January 2017
Blake Wilbur	Replaced 1.5T with 3T MRI	January 2017
	Upgraded 1.5T MRI to new platform	Winter 2017
Hoover	New Digital Breast Tomosynthesis System	Winter 2017
Redwood City	New Wide Bore MRI	Fall 2017

New/Upgraded Research Equipment

Location	Equipment
Clark Center SCI[3]	7T MRI small animal system upgrade
	microCT replacement
	Magnetic Particle Imaging Instrument
Canary Center	Data Servers, Hi-Speed Centrifuges, Gas Chromatograph, Microscope(s), Fluorescence Imaging Systems
Lucas Center	MRI hardware and software upgrade with high-end gradients and new technology
	Siting of investigational Neuro MR-guided focused ultrasound (MRgFUS) device designed to open the blood brain barrier (BBB) to allow treatment of primary and malignant brain tumors

Feature

The Cyclotron and Radiochemistry Facility

The Cyclotron and Radiochemistry Facility (CRF) develops and delivers radioactively-labeled imaging probes, also called radiotracers, for use in early detection, therapeutic monitoring, and theranostic treatment of disease. These radiotracers are used to support clinical imaging scans (such as PET and SPECT) as well as research studies at the Stanford Hospital, the Lucile Packard Children's Hospital, and the Stanford Center for Innovation in *In Vivo* Imaging (SCI^3). Radiotracers are injected into living subjects during a PET or SPECT scan to non-invasively visualize internal biological targets of interest; many of these radiotracers are applied in the areas of oncology, cardiology, and neurological diseases.

CRF Personnel (left to right): Zheng Miao, Jessa Castillo, George Montoya, Jun Hyung Park, Frederick Chin (Director), Shawn Scatliffe, Murugesan Subbarayan, Carmen Azevedo, and Bin Shen (Manager). Missing: Mia Koknar-Tockey

The CRF is the main radiochemistry facility at Stanford with the primary mission of providing expertise in the design, synthesis, and production of current and new imaging probes. Leadership of the facility is provided by Dr. Frederick T. Chin (Director, CRF since 2005) and Dr. Bin Shen (Manager, CRF since 2016). In total, nearly 30 radiochemistry personnel (including students, staff, and faculty) operate this facility daily and support its mission.

CYCLOTRON

The heart of the CRF is a 16.5 MeV GE PETtrace 880 cyclotron, which is used for the production of radioisotopes for both clinical and research use. The cyclotron runs on demand to support delivery of ^{18}F-, ^{11}C-, ^{15}N-, and ^{15}O-isotopes as needed for each day's radiochemistry schedule. In addition, the CRF can provide other radiometals (e.g., ^{68}Ga, ^{64}Cu, and ^{89}Zr) to chelate to various biologics. Timely delivery of radiotracers is the essential final step in the operation of the CRF, especially because several routinely-used clinical radiotracers have half-lives of approximately 110 minutes or less; using radiotracers beyond their designed timeframe (due to radioactive decay and required molar activity) renders them ineffective for clinical or research use.

CLINICAL RADIOTRACER PRODUCTION

Adjacent to the cyclotron is the GMP production facility, equipped to synthesize routine radiotracers while abiding to the current regulatory policies. Since 2006, the CRF continues to provide ^{18}F-FDG to Stanford Hospitals and Clinics for patient standard-of-care (approximately 5,500 doses/year) and will begin serving other newly-acquired satellite Stanford Hospitals in the Bay Area. To date, more than 30 tracers (with many others currently pending under FDA/RDRC review) can be ordered from the CRF for clinical use, clinical research, or clinical trials. The number of available tracers has grown significantly over the past 12 years and is a statement of the dedication of the CRF to meet the needs of patients and its commitment to innovation in developing new imaging methodologies.

PRE-CLINICAL RESEARCH AND TRANSLATION

In addition to radiotracer production for clinical use, the CRF includes space for hot labs, fully equipped for research and development of new radiotracers. This key facet of the CRF supports the vision of the Molecular Imaging Program at Stanford (MIPS) which was established in 2003 as an interdisciplinary initiative at Stanford Medicine. The goal of these efforts is to advance molecular imaging of living subjects by providing state-of-the-art molecular imaging strategies to improve our understanding of the *in vivo* biological events during disease progression and to focus on clinical translation for improved patient care.

Radiology Translational Research: Innovation through Collaboration

Over the past several decades, the value of translational research in advancing clinical care, that is, moving scientific discovery to clinical practice, is unquestionable. Radiology, as a discipline, has played a significant role in this "bench-to-bedside" transition, with the successful integration of physics and computer technology with clinical applications. Relatively new techniques evolving out of the imaging field are now integrated into routine clinical practice and are beginning to revolutionize the diagnosis of onset of disease, monitoring of progression, and the effectiveness of treatment.

During FY17, more than $55 million in sponsored funding was awarded to the department's clinical and research divisions. By fostering multidisciplinary research partnerships between clinicians and researchers to address complex human health issues, faculty and researchers in the department continue to push the boundaries of scientific discovery and clinical practice with innovative translational research outcomes.

In the following few pages, we highlight four Translational Research programs that have had a positive effect on the lives of patients and offer great promise and inspiration to similar ongoing translational research projects.

I. Microbubbles and Early Detection of Cancer

II. Illuminating Pain Generators with PET-MR

III. Fluorescence Imaging for Visual Guidance in Cancer Surgery

IV. Emergency Neuroendovascular Surgery for Acute Ischemic Stroke Treatment

The translational stories are a result of the clinicians focusing on patient needs while partnering with their basic science colleagues to jointly ensure optimum performance in the clinic. The department aims to maintain this momentum in translational research by continuing to provide advanced resources and a strong environment where clinical care and research are valued and encouraged.

Microbubbles and Early Detection of Cancer

PROJECT NAME

Microbubbles and Early Detection of Cancer

PROJECT LEADER

Juergen Willmann, MD

SELECTED FUNDING

Automated Volumetric Molecular Ultrasound for Breast Cancer Imaging. NIH/NCI 1 R01 CA218204 01 (Willmann/Dahl)

Molecular Spectroscopic Photoacoustic Imaging for Breast Lesion Characterization. NIH/NIBIB 5 R21 EB022214 02 (Willmann)

3D Passive Cavitation Imaging-Guided Therapeutic Delivery of MicroRNA into Cancer. NIH/NIBIB 5 R21 EB022298 02 (Willmann, Paulmurugan)

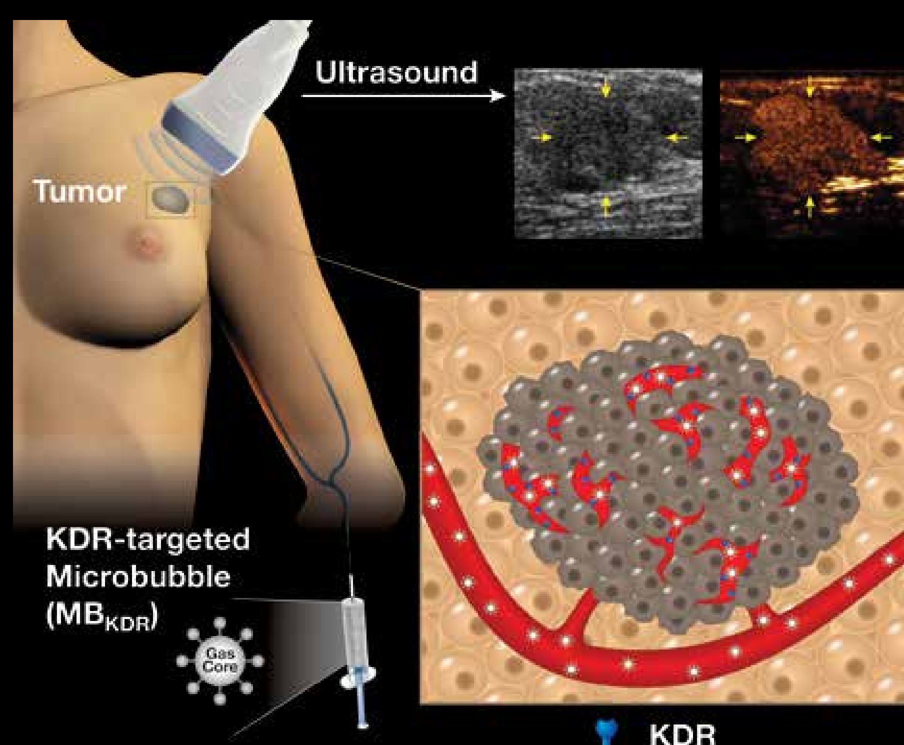
SELECTED PUBLICATIONS

Willmann, JK, Bonomo L, Carla Testa A, Rinaldi P, Rindi G, Valluru KS, Petrone G, Martini M, Lutz AM, Gambhir SS. Ultrasound Molecular Imaging With BR55 in Patients With Breast and Ovarian Lesions: First-in-Human Results. Journal of Clinical Oncology. 2017 Jul 1; 35(19):2133–2140. PMCID: PMC5493049

Is it now possible to distinguish non-cancerous from cancerous lesions without biopsy or surgery? A Stanford Radiology team, led by Juergen Willmann, MD, has compelling evidence that this may be possible using an advanced ultrasound imaging approach.

Motivated by the NCI's commitment to early cancer detection and improved patient outcome, Dr. Willmann began his work with microbubbles and ultrasound in 2008 as a new faculty member in the Department of Radiology at Stanford. His primary goal was to develop a relatively low cost, non-invasive method to diagnose breast cancer early, at manageable stages. His NCI-funded work in the research laboratory provided the foundation and encouragement toward translation of this work to patients. Dr. Willmann and his team have maintained a singular focus of reducing the number of false positive breast cancer diagnoses using a non-invasive ultrasound molecular imaging (USMI) technique.

Ultrasound is a valuable imaging modality that has the potential to be the ideal imaging and screening tool for early breast cancer detection. It is non-invasive and relatively inexpensive compared to other imaging modalities, it does not use ionizing radiation, it has a high spatial and temporal resolution, and is available in nearly all clinical imaging facilities worldwide. However, ultrasound often lacks sensitivity and specificity, making accurate interpretation of findings more difficult. Recognizing this potential deficiency, the Willmann laboratory combined the advantages of ultrasound with the advantages of more sensitive imaging technologies and molecularly targeted ultrasound contrast microbubbles.



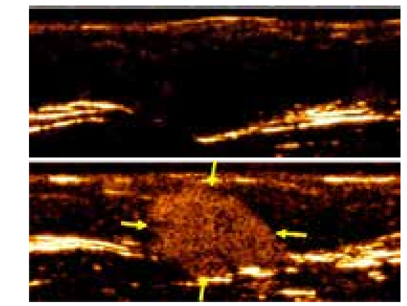
Schematic showing the concept of ultrasound molecular imaging (USMI) in patients with breast cancer. The kinase insert domain receptor (KDR)-targeted microbubbles (MB_{KDR}) are injected intravenously. While MB_{KDR} bubbles freely circulate in the vasculature, they attach to the newly-formed blood vessels that over express KDR (shown as blue receptor). With clinical ultrasound, the accumulation of MB_{KDR} in breast cancer (yellow arrows in top images) can be seen as a strong signal on contrast mode image (right). Note that the brightness mode is shown to the left of the contrast mode image for anatomic reference.

Microbubbles are small gas-filled spheres (1–4 micrometers in diameter), composed of a lipid or protein shell and filled with a harmless gas (air or perfluorocarbon); these are FDA-approved and have been in use for several years as a contrast agent for ultrasound imaging.

Through resources provided by the Molecular Imaging Program at Stanford (MIPS), Dr. Willmann has been able to carefully adapt the use of microbubbles. His team developed a new microbubble (MB_{KDR}) that identifies and attaches to a specific receptor, the kinase insert domain receptor (KDR), which is found in abundance on newly formed blood vessels in cancerous lesions. This targeted USMI approach is proving to be a reliable method for earlier detection of breast cancer.

In pre-clinical work, Dr. Willmann and his colleagues have shown that KDR-targeted microbubbles successfully find and attach to the KDR receptor, effectively outlining the cancerous tumor on ultrasound, making it much easier to distinguish from non-cancerous tumors. In longitudinal screening exams in transgenic mice with mammary glands progressing from normal breast tissue to invasive breast cancer, the team demonstrated the diagnostic accuracy of ultrasound with KDR-targeted microbubbles *in vivo*.

This early work in the laboratory led to a first-in-human clinical feasibility, safety, and efficacy trial on KDR-targeted molecular ultrasound imaging in women with various breast and ovarian pathologies. As a collaboration between Stanford University Hospital and Catholic University Hospital in Rome, Italy, these two sites recruited and studied 21 women with focal breast lesions and 24 women with focal ovarian lesions. Histology was used as the gold standard in each case. Based on this early collaborative study, the team confirmed that USMI with MB_{KDR} is well tolerated with no serious adverse events. Through this initial clinical study, the team has further refined molecular ultrasound imaging for early breast cancer detection and continues to evolve next generation contrast microbubbles targeted to breast cancer-specific molecular targets. As a direct result of their pre-clinical and early first-in-human studies, Dr. Willmann and team is now launching a recently funded NIH clinical trial (1 R01 CA218204 01) using the advanced USMI KDR-targeted microbubbles to continue the mission of improving patient care and survival by diagnosing breast cancer at a much earlier and more manageable stage.



(Top) On a contrast mode image obtained before contrast agent administration. (Bottom) Transverse contrast mode image obtained at 11 minutes after intravenous administration of KDR-targeted contrast microbubbles (MB_{KDR}) show strong and persistent targeted ultrasound image signal in breast cancer and low background signal.

The advantages of USMI and microbubbles are many, including that the procedure is non-invasive, well-tolerated, and also promises to reduce wait-time for results, thereby relieving an individual's fear of disease and allowing those with cancerous lesions to move more promptly into treatment plans. Indeed, Dr. Willmann's research focus perfectly aligns with the mission of the Canary Center at Stanford for Cancer Early Detection (pages 80–81); he has been a Full Member of the Canary Center since its formation in June 2009.

Illuminating Pain Generators with PET-MR

PROJECT NAME

Illuminating Pain Generators

PROJECT LEADERS

Sandip Biswal, MD
Frederick T. Chin, PhD
Christopher McCurdy, PhD
DaeHyun Yoon, PhD
Peter Cipriano, BA
Trine Hjørnevik, PhD
Catherine Curtin, MD
Ian Carroll, MD, PhD
Vivianne Tawfik, MD, PhD

SELECTED FUNDING

Funding, in part, by GE Healthcare

SELECTED PUBLICATIONS

Shen B, Behera D, James ML, Reyes ST, Andrews L, Cipriano PW, Klukinov M, Lutz AB, Mavlyutov T, Rosenberg J, Ruoho AE, McCurdy CR, Gambhir SS, Yeomans DC, Biswal S, Chin FT. Visualizing Nerve Injury in a Neuropathic Pain Model with [18F]FTC-146 PET-MRI. Theranostics, 2017 Jul 8; 7(11):2794–2805. PMCID: PMC5562216.

Hjørnevik T, Cipriano PW, Shen B, Hyung Park J, Gulaka P, Holley D, Gandhi H, Yoon D, Mittra ES, Zaharchuk G, Gambhir SS, McCurdy CR, Chin FT, Biswal S. Biodistribution and Radiation Dosimetry of 18F-FTC-146 In Humans. Journal of Nuclear Medicine, 2017 Jun 1. (Epub ahead of print).

Shen B, Park JH, Hjørnevik T, Cipriano PW, Yoon D, Gulaka PK, Holly D, Behera D, Avery BA, Gambhir SS, McCurdy CR, Biswal S, Chin FT. Radiosynthesis and First-In-Human PET-MRI Evaluation with Clinical-Grade [18F]FTC-146. Molecular Imaging and Biology, 2017 Mar 9. (Epub ahead of print).

Pain encumbers the lives of millions of people around the world. The source of an individual's pain is often elusive. Each person's pain is unique in how they feel it and how much it affects their quality of life. In the United States alone, the number of individuals suffering from pain is staggering—more than half of the adult population suffers with some form of pain. Without an exact cause of a person's pain, treatment can often be unsuccessful and unnecessary.

A team of scientists from Stanford University and the University of Mississippi (Drs. Sandip Biswal, Fred Chin, Christopher McCurdy, et al.) have developed a novel way to visualize pain. They have created a radiotracer, ^{18}F-FTC-146, that finds and illuminates the sigma-1-receptors (S1R) on cells. The sigma-1-receptor has been shown to have a direct effect in modulating pain. When a part of the body is in pain, a greater number of S1Rs are present on the cells in the area of pain. Researchers have now found a way to use these receptors to pinpoint pain in the body.

PET-MRI image of ^{18}F-FTC-146 uptake in area behind the left knee, previously unseen on MRI only. Subsequent arthroscopy revealed this area to be an inflamed synovial lipoma. This lesion was removed and the patient has been pain free for the first time in approximately eight years.

A patient participating in a recent PET-MRI clinical trial at Stanford Medicine had been suffering from debilitating knee pain for more than seven years—a sharp pain that started just behind the inside of her knee and radiated down into her leg and foot. The patient classified her pain as a 10 on a scale of 1–10, with 10 being the most severe. The knee pain had affected her mobility; she was unable to sit or stand, unable to walk on grass, downhill, or down the stairs without excruciating knee pain. Routine knee movements increasingly generated a stabbing pain that wrapped around to the front of her knee.

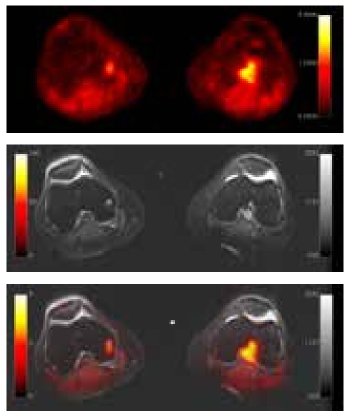
Since this patient with atypical pain of unknown origin had already endured multiple surgeries and other unsuccessful treatments, she was referred to the multidisciplinary Stanford Pain Management Center, where she was enrolled in a clinical trial led by Dr. Sandip Biswal, Associate Professor of Radiology.

Using a new hybrid imaging technique, positron emission tomography (PET) with magnetic resonance imaging (MRI), PET-MRI images were acquired after injecting a sigma-1 receptor radiotracer, ^{18}F-FTC-146, into the patient. PET-MRI imaging successfully illuminated a previously unseen inflamed mass inside the patient's left knee. The same inflamed mass was located, biopsied and removed during a subsequent arthroscopic surgical procedure. Biopsy results revealed an inflamed synovial lipoma, a rare intra-articular lesion consisting of inflamed fatty tissue.

Immediately following the surgery, the patient rated her pain a 4, much improved over the 10 rating prior to surgery. Within days, the pain subsided to a level 2 and she reported being able to sit and stand comfortably, walk on grass, and walk downhill without distress. Five months after the final surgery, the patient unbelievingly exclaimed, "I have no pain!"

While every case of pain is unique and not all will have an outright cure for the pain, this research is extremely promising, and a significant step forward in our understanding, management, and treatment of debilitating chronic pain. Imagine a world where your pain is visualized by a glowing tracer, a tracer that will point out the precise origin of the pain. Imagine a world where you get the most effective treatment for your pain right from the start, so that your quality of life is not impacted much.

Stanford Radiology, led by innovative, creative, and dedicated clinicians and scientists, moves us closer each day to a type of personalized medicine that is no longer considered unique, but is a critical part of routine patient care.



PET-MRI image (Bottom) of ^{18}F-FTC-146 uptake in area behind the left knee, previously unseen on MRI only. Top: PET image, Middle: MRI

> “…pain free for the first time in almost eight years.”
>
> PATIENT

Fluorescence Imaging for Visual Guidance in Cancer Surgery

PROJECT NAME

Fluorescence Imaging for Visual Guidance in Cancer Surgery

PROJECT LEADER

Eben Rosenthal, MD

SELECTED FUNDING

Prototype Optical Device for Image Guided Surgery with Panitumumab-IRDye800. NIH/NCI 5 R01 CA190306 03 (Rosenthal)

SELECTED PUBLICATIONS

Rosenthal EL, Moore LS, Tipirneni K, de Boer E, Stevens TM, Hartman YE, Carroll WR, Zinn KR, Warram JM. Sensitivity and Specificity of Cetuximab-IRDye800CW to Identify Regional Metastatic Disease in Head and Neck Cancer. Clinical Cancer Research, 2017 Aug 15; 23(16):4744–4752.

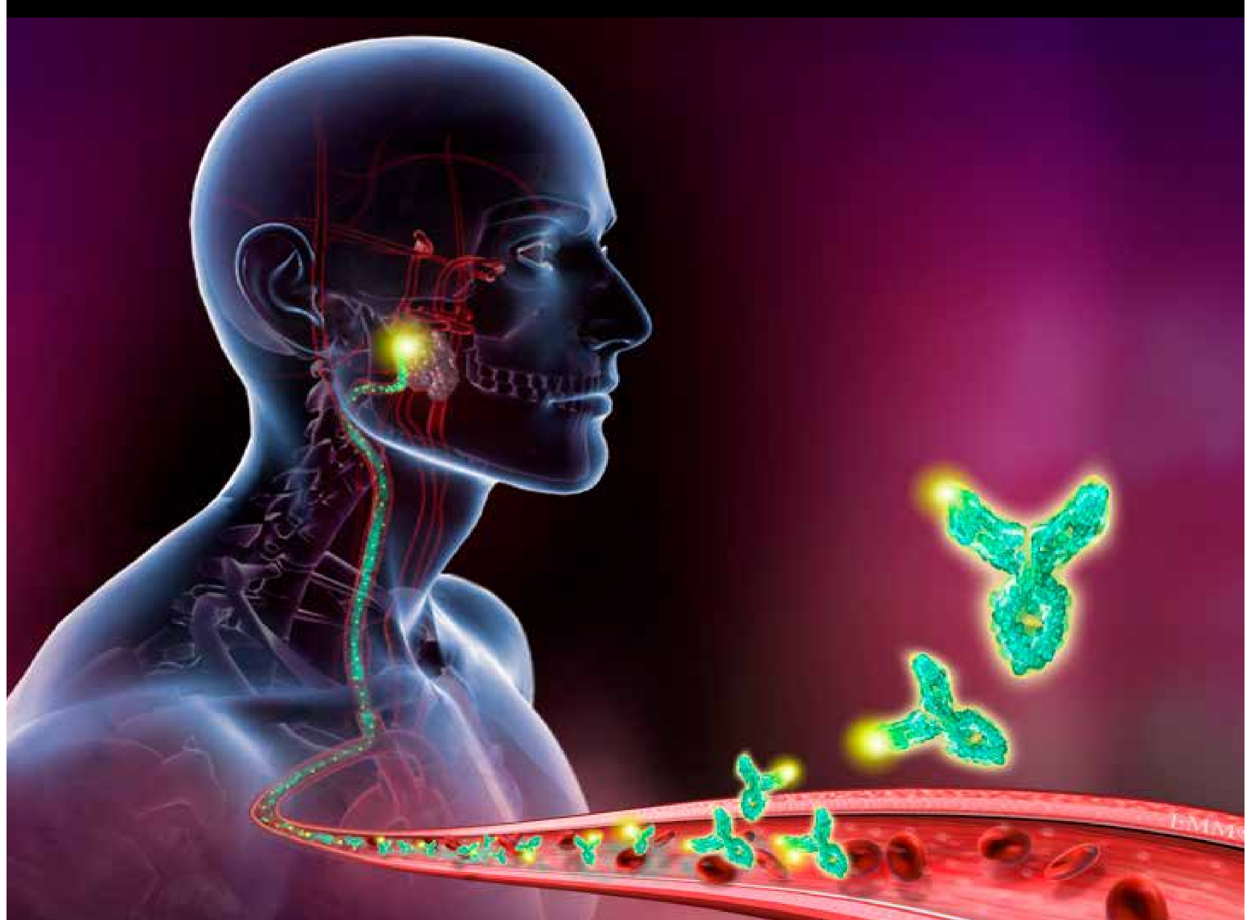
Zhang RR, Schroeder AB, Grudzinski JJ, Rosenthal EL, Warram JM, Pinchuk AN, Eliceiri KW, Kuo JS, Weichert JP. Beyond the Margins: Real-Time Detection of Cancer Using Targeted Fluorophores. Nature Reviews Clinical Oncology, 2017 Jun; 14(6):347–364.

Harmsen S, Teraphongphom N, Tweedle MF, Basilion JP, Rosenthal EL. Optical Surgical Navigation for Precision in Tumor Resections. Molecular Imaging Biology, 2017 Jun; 19(3):357–362. PMCID: PMC5567813

An ever-present concern for cancer surgeons is the issue of whether complete removal of tumor tissue has been achieved.

For many years, surgical removal of solid tumors has relied on the surgeon's skill for visual inspection and the ability to palpate the surgical site and tumor for any tumor tissue left behind. Unfortunately, this well-practiced, but very subjective skill set, frequently results in either removal of normal tissue or incomplete tumor excision, or both—all of which are suboptimal. In order to enhance tumor visibility for the surgeon, fluorescence imaging, a type of optical imaging that uses fluorescent dyes, was introduced during the 1940s; due to various limitations, this approach was not broadly adopted. Since then, both technology and chemistry have improved dramatically to develop more sensitive imaging equipment and accurately target specific fluorescent chemical compounds (fluorophores).

Preclinical work by Dr. Rosenthal's group with tumor targeting antibodies has provided high tumor-to-background ratios in head and neck, skin, breast, brain, and other cancers. This work has eventually led to IND-enabling toxicology studies that permitted successful first-in-human clinical trials using near-infrared (NIR) labeled antibodies for surgical and pathological navigation during head and neck cancer surgery.



Graphic depiction of a near-infrared labeled antibody being infused prior to surgery. The bright spot depicts localization of targeted antibody in a tumor.

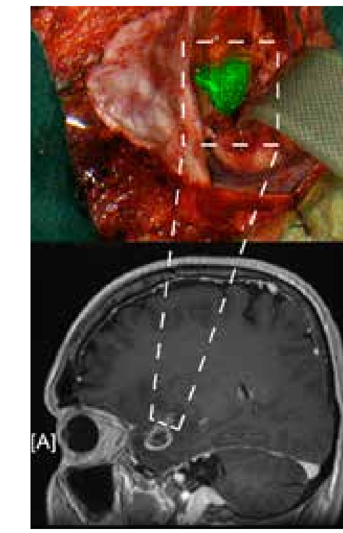
Dr. Rosenthal's work in surgical imaging within the operating room suite is being conducted to guide surgical removal of tumors by identifying clean margins to leave nothing of the lesion behind. They are currently evaluating a number of novel tumor targeting probes, including several antibodies labeled with near-infrared fluorescent dyes. Their work with collaborators at Stanford, University of Alabama at Birmingham, and from around the world, has resulted in novel probes, dyes, and devices for real-time cancer detection. We are well on our way to improving the efficacy of oncologic surgery and recognizing significant patient benefits from real-time surgical imaging.

Patient preparation for fluorescence imaging during a surgical procedure requires the patient to visit the clinic for a pre-surgical infusion of the fluorescently labeled antibody prior to surgery. During surgery, a portable near-infrared (NIR) imaging system is used to identify the lesion(s) prior to excision. Once the tumor is removed, the surgical field is imaged again to verify that all tumor tissue has been removed. Rapidly advancing intraoperative fluorescence imaging approaches, which allow for real-time imaging, maximize the surgeon's ability for complete tumor resection.

The long-term goal is to combine targeted fluorescence imaging that allows for complete resection of the tumor with photodynamic therapy that applies focused light therapy to kill any tumor cells that may not have been captured during surgery. The photodynamic therapy can be considered the "final sweep" that, following surgical removal of the tumor, quickly identifies straggling cells and destroys them while the patient is still on the operating table.

The advantages of fluorescence imaging during surgery are many including: (i) Tumor margins become well defined. (ii) Clinically used probes are non-toxic and safe for patient use. (iii) There is no radiation exposure to the patient. (iv) Fluorescence imaging equipment is relatively low-cost and unobtrusive in the operating room.

While one can never be one hundred percent sure of "getting all of the tumor" and work towards this goal remains, it can be said with certainty that since the introduction of optical imaging, this approach has resulted in greater surgical visibility, an increased confidence level in surgical performance, and a higher surgical success rate in the operating room.



Intraoperative fluorescence image (with associated MRI) following panitumumab-IRDye800 infusion. A high-dose contrast enhancing glioblastoma patient pre-resection after dura was reflected and tumor surface visualized.

> "…fluorescence imaging...maximizes the surgeon's ability for complete tumor resection."

PROJECT NAME

Emergency Neuroendovascular Surgery for Acute Ischemic Stroke Treatment

PROJECT LEADER

Michael Marks, MD
Jeremy Heit, MD, PhD
Greg Zaharchuk, MD, PhD

SELECTED FUNDING

Resting State Spontaneous Fluctuations of the BOLD Signal for Penumbra Assessment in Endovascular Stroke Candidates. RSNA Research Scholar Grant (Heit)

Imaging Collaterals in Acute Stroke. NIH/NINDS 5 R01 NS066506 08 (Zaharchuk)

Stanford University Regional Coordinating Stroke Center for the NINDS Stroke TRIA. NIH/NINDS 5 U01 NS086487 05 (Albers, Heit, Marks, Zaharchuk)

SELECTED PUBLICATIONS

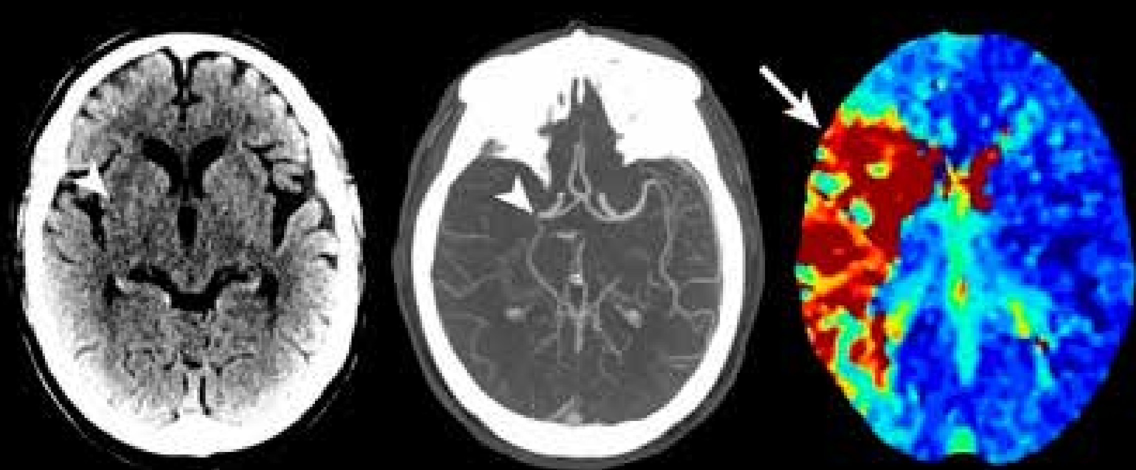
Heit JJ, Wong JH, Mofaff AM, Telischak NA, Dodd RL, Marks MP, Do HM. Sofia Intermediate Catheter and the SNAKE Technique: Safety and Efficacy of the Sofia Catheter without Guidewire or Microcatheter Construct. Journal of NeuroInterventional Surgery, 2017 Aug 2. (Epub ahead of print).

Wong JH, Do HM, Telischak NA, Moraff AM, Dodd RL, Marks MP, Ingle SM, Heit JJ. Initial Experience with SOFIA as an Intermediate Catheter in Mechanical Thrombectomy for Acute Ischemic Stroke. Journal of NeuroInterventional Surgery, 2016 Oct 27. (Epub ahead of print).

Patel VP, Heit JJ. Ischemic Stroke Treatment Trials: Neuroimaging Advancements and Implications. Topics in Magnetic Resonance Imaging, 2017 Jun; 26(3):133–139.

Emergency Neuroendovascular Surgery for Acute Ischemic Stroke Treatment

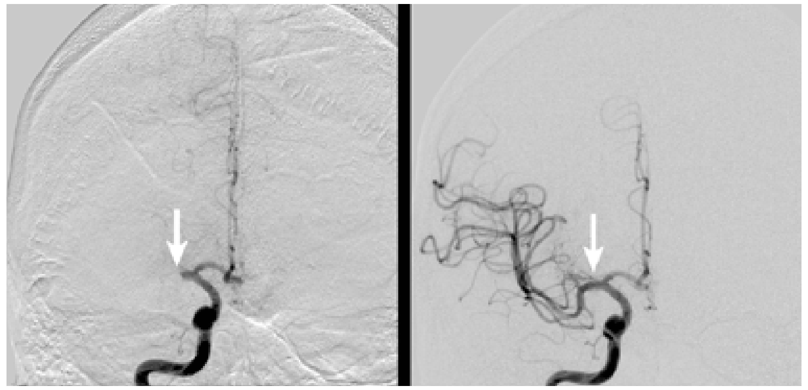
The Stanford Advanced Comprehensive Stroke Center was established in 1992 by Michael Marks, MD, an interventional neuroradiologist; Gregory Albers, MD, a vascular neurologist; and Gary Steinberg, MD, PhD, a cerebrovascular neurosurgeon. In 2004, the Stroke Center was designated by the Joint Commission as a Primary Stroke Center, and in 2012, the Stanford Stroke Center became the first ever stroke center designated as an Advanced Comprehensive Stroke Center. While more than 1,000 hospitals have become Joint Commission certified as Primary Stroke Centers, there are only 33 centers with the "Advanced Comprehensive" designation. This is a tribute to the leadership of the Stanford Stroke Center, coming from multiple fields and working together by focusing their expertise and dedication to research and clinical care in this area of medicine.



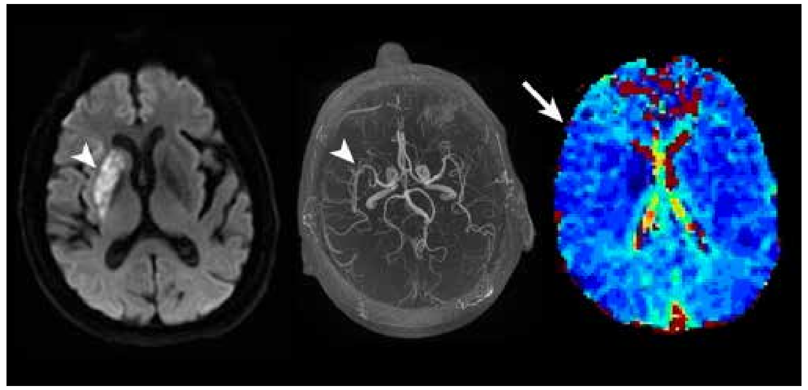
The patient presented with an ischemic stroke causing complete paralysis of the left side of the body. A non-contrast head CT shows a small early stroke (first panel, arrowhead). A CT angiogram shows blockage of the right middle cerebral artery (second panel, arrowhead). A CT perfusion blood flow study shows critically delayed blood flow past the blocked middle cerebral artery (third panel, red region indicated by arrow).

Faculty from the Department of Radiology work closely with their colleagues in neurology and neurosurgery to provide emergency imaging and treatment of stroke patients. Ischemic stroke is caused by blockage of an artery that provides blood to the brain (similar to how an artery blockage in the heart causes a heart attack). Blockage of a major artery in the brain is the leading cause of disability and the fourth leading cause of death in the United States. Each minute a major brain artery remains blocked, two million neurons die. Therefore, treatment of patients with ischemic stroke must be performed extremely promptly to prevent permanent neurologic damage.

The Stanford Comprehensive Stroke Center cares for patients with ischemic stroke from all over Northern and Central California, and 85% of patients treated arrive by the Stanford Life Flight emergency helicopter transfer. Upon arrival, patients are transferred directly to the Department of Radiology CT and MRI scanners, where they are clinically evaluated by attending physicians and clinical fellows from the Department of Radiology (Division of Interventional Neuroradiology) and the Department of Neurology (Division of Stroke and Neurocritical Care). These patients then undergo rapid imaging evaluation with advanced CT and MRI techniques to determine the best treatment. Research from the Stanford Comprehensive Stroke Center is advancing the treatment of ischemic stroke patients by extending the time window of treatment from 4.5 hours to 16–24 hours using new emergency neuroendovascular stroke surgeries. Stanford interventional neuroradiologists are able to open blocked arteries in the brain using these image-guided, minimally invasive brain surgeries in greater than 90% of patients eligible for treatment. Patients successfully treated with these endovascular surgeries are three times as likely to recover from their ischemic stroke without a significant neurologic deficit and return to a normal life.



A digital subtraction angiogram performed after placement of a catheter into the internal carotid artery in the right neck before the blocked middle cerebral artery. Blood flow is indicated by the black contrast dye injected from the catheter, and the blocked middle cerebral artery is evident (first panel, arrow). Emergency retrieval of the blood clot in the middle cerebral artery completely restored normal blood flow to the right middle cerebral artery (second panel, arrow). The entire procedure was performed in 14 minutes.



A brain MRI performed the day after emergency endovascular stroke treatment shows a small stroke in the right brain (first panel, arrowhead). An MR angiogram shows completely restored blood flow within the right middle cerebral artery (second panel, arrowhead). An MR perfusion blood flow study shows completely normalized blood flow within the right middle cerebral artery (third panel, arrow). The patient walked out of the hospital after discharge two days after endovascular treatment with a completely normal neurologic examination.

VICE CHAIR, EDUCATION AND CLINICAL OPERATIONS

David Larson, MD, MBA (9/1/2017–Present)

ASSOCIATE CHAIR, EDUCATION

Michael Federle, MD (10/1/2008–12/31/2017)

ASSOCIATE CHAIR, CLINICAL EDUCATION

Christopher Beaulieu, MD, PhD (1/1/2018–Present)

RADIOLOGY RESIDENCY

Payam Massaband, MD
Bruce Daniel, MD
Gloria Hwang, MD
Michael Iv, MD
Erika Rubesova, MD
Ali Tahvildari, MD

NUCLEAR MEDICINE RESIDENCY

Andrei Iagaru, MD

INTERVENTIONAL RADIOLOGY-DIAGNOSTIC RADIOLOGY RESIDENCY

William Kuo, MD

SCIT PROGRAM

Stanford Cancer Imaging Training Program
Sandy Napel, PhD
Bruce Daniel, MD

SMIS PROGRAM

Stanford Molecular Imaging Scholars Program
Craig Levin, PhD

TBI² PROGRAM

Training in Biomedical Imaging & Instrumentation Program
Kim Butts Pauly, PhD
Norbert Pelc, ScD

CSBS PROGRAM

Cancer Systems Biology Scholars Program
Sylvia Plevritis, PhD

CANCER-TNT PROGRAM

Cancer-Translational Nanotechnology Training Program
Jianghong Rao, PhD

CANARY CREST PROGRAM

Canary Cancer Research Education Summer Training Program
H. Tom Soh, PhD
Utkan Demirci, PhD

ARTS PROGRAM

Advanced Residency Training at Stanford Program
Sanjiv Sam Gambhir, MD, PhD

Training Programs

In keeping with the department's commitment of providing exceptional clinical care and cutting-edge research, the Department of Radiology offers both clinical and research training programs that encompass all radiology subspecialties and modalities. The programs offered include three residency programs, ten clinical postdoctoral fellowship programs, and six research training programs.

The goal of the **residency programs** (pages 53–55) is to develop and refine the broad capabilities necessary to become outstanding radiologists who are able to manage diverse patient cases with a broad range of disorders and diseases, with the highest ethical and professional standards of radiologic and medical care.

The department's **clinical fellowships** (pages 56–57) are carefully designed to advance the knowledge and technical skills of fellows in subspecialty areas through extensive clinical, research, and teaching opportunities, and to prepare them for leadership positions in clinical practice.

Research training programs (pages 58–63) are available to graduate students and postdoctoral candidates, and also to undergraduate students specifically for training during the summer months. These programs provide training in mentored research and career development that prepares individuals to conduct innovative research in cancer imaging, molecular imaging, physics and instrumentation, systems biology, nanotechnology, and early detection of cancer.

All training programs are directed by exceptionally dedicated faculty with a strong management and administrative team to oversee every aspect of the program to ensure that trainees are part of a structured, well organized, and positive learning environment. The following pages (52–63) provide highlights of each program offered through the Department of Radiology.

Clinical Training Programs

The Department of Radiology continues to offer comprehensive clinical training in all radiology sub-specialties through its residency and clinical fellowship programs. These programs offer an exceptional training experience by encouraging trainees to interact and learn from dedicated faculty who are devoted to teaching, outstanding patient care, and translational research. The robust learning experience is coupled with the opportunity to rotate through the Stanford University Hospital, the Lucile Packard Children's Hospital, VA Palo Alto Health Care System, and Santa Clara Valley Medical Center. Trainees function as part of a clinical team responsible for the performance and interpretation of inpatient and outpatient cases. Because Stanford Radiology faculty are actively engaged in research, residents and fellows alike are exposed to outstanding research opportunities with close ties to leading engineers, and physicists, thereby allowing for participation and presentation at national meetings, conferences, and workshops.

Radiology Residency Programs

The three residency training programs—the Diagnostic Radiology Residency Program, the Dual Pathway Nuclear Medicine and Diagnostic Radiology Residency Program, and the Interventional Radiology-Diagnostic Radiology Integrated Residency Program—provide a supportive yet rigorous environment for residency training. The Diagnostic Radiology Residency Program has historically been the largest and longest-offered program at Stanford Radiology, and has anchored the development of the two new residency programs to broaden the scope of training options.

Clinical Fellowship Programs

The department offers 10 one- and two-year postdoctoral fellowships across the different clinical divisions. Fellowships begin July 1 of each year.

Radiology Residency Programs

DIAGNOSTIC RADIOLOGY RESIDENCY PROGRAM

The goal of the Stanford Diagnostic Radiology Residency Program is to train future leaders of the field, leveraging the clinical strength of Stanford Health Care and affiliates, the research prowess of Stanford University, and the culture of innovation in Silicon Valley. Trainees will continue to help develop the diagnostic and therapeutic modalities of tomorrow, performing cutting-edge research, and translational clinical work. Graduates of the Stanford Radiology Residency Program have established leadership roles in academic radiology departments, research programs, and within industry.

Payam Massaband, MD
Program Director

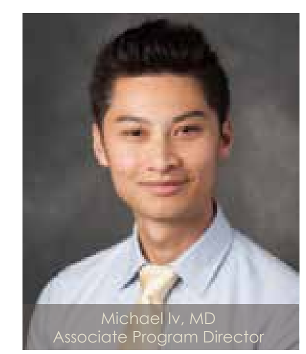
The residency program provides a supportive yet rigorous environment to learn from an internationally acclaimed faculty, known for superb teaching, outstanding patient care, and world-class research. Our program offers a rich clinical exposure through a wide variety of rotations that provide care to the diverse patient populations and by understanding the role of imaging studies within the larger context of patient health care.

The curriculum of the Diagnostic Radiology Residency Program affords residents the flexibility to pursue personal and professional endeavors about which they feel truly passionate. Most residents devote time during their four-year residency to perform cutting-edge research, advance informatics, launch innovative companies, hone clinical skills through early clinical subspecialization, learn medical design innovation, and participate in hospital-wide quality improvement projects.

Bruce Daniel, MD
Associate Program Director

Since July 2015, the residency program has been directed by Dr. Payam Massaband, a staff radiologist at the VA Palo Alto since graduating from Radiology residency and fellowship at Stanford in 2010. He spent three years as the VA Palo Alto acting chief of Radiology, concentrating on clinical excellence, process improvement and residency education. Dr. Massaband is supported by five associate program directors (Dr. Bruce Daniel, Dr. Gloria Hwang, Dr. Michael Iv, Dr. Erika Rubesova, Dr. Ali Tahvildari) and two program managers, who oversee different aspects of the program.

Gloria Hwang, MD
Associate Program Director



Michael Iv, MD
Associate Program Director

Erika Rubesova, MD
Associate Program Director

Ali Tahvildari, MD
Associate Program Director

DUAL PATHWAY NUCLEAR MEDICINE AND DIAGNOSTIC RADIOLOGY RESIDENCY PROGRAM

Andrei Iagaru, MD
Program Director

Restructured in 2015–2016, the five year ACGME-approved Dual Pathway Nuclear Medicine and Diagnostic Radiology Residency Program thrives to educate the next generation of worldwide leaders in academic and clinical nuclear medicine and molecular imaging. The program includes education in all aspects of the basic sciences, diagnostics, and therapy as they relate to nuclear medicine. Ample research opportunities are provided to take advantage of resources such as the Molecular Imaging Program at Stanford (MIPS) and the Research PET-MRI Program at Stanford. Clinical training takes place at Stanford Health Care, Lucile Packard Children's Hospital at Stanford, and the VA Palo Alto Health Care System. At the end of the residency, trainees are expected to successfully sit for the ABNM and ABR certification examinations.

Trainees spend one year in the Nuclear Medicine program, followed by the next four years in the Diagnostic Radiology program; the final diagnostic radiology year is spent with a focus on research, nuclear medicine, and molecular imaging. Trainees are fully integrated into both ACGME-accredited programs (nuclear medicine and diagnostic radiology). This dual pathway is being pioneered at Stanford University with the goal of offering dedicated research time throughout the five years of training.

The Dual Pathway Nuclear Medicine and Diagnostic Radiology Residency Program is directed by Dr. Andrei Iagaru, Chief of the Division of Nuclear Medicine and Molecular Imaging at Stanford Health Care.

INTEGRATED INTERVENTIONAL RADIOLOGY-DIAGNOSTIC RADIOLOGY RESIDENCY PROGRAM

William Kuo, MD
Program Director

The Integrated Interventional Radiology-Diagnostic Radiology Residency Program is a five year ACGME-accredited program that integrates three years of diagnostic radiology (DR) with two final years of dedicated interventional radiology (IR) training. The program offers a robust educational curriculum spanning the full spectrum of image-guided interventions and beyond, including cutting-edge protocols and treatments pioneered by Stanford Interventional Radiology. Candidates may enter the integrated IR-DR Residency directly from medical school following a one year surgical internship. After completing the residency, graduates will qualify to obtain a dual IR-DR certificate from the American Board of Radiology.

The Stanford Division of Vascular and Interventional Radiology is a tertiary and quaternary referral center that accepts complex cases from around the country and around the world, ensuring that our trainees are exposed to a broad and intriguing case mix. In addition to advanced specialty training at Stanford University Medical Center, the residency program integrates clinical training across multiple sites and disciplines including the VA Palo Alto Health Care System, Lucile Packard Children's Hospital, Santa Clara Valley Medical Center, outpatient Interventional Radiology Clinics, multidisciplinary clinical electives and a dedicated Cardiovascular ICU rotation. The Integrated IR-DR Residency Program is directed by Dr. William Kuo.

Clinical Fellowship Programs

BODY IMAGING FELLOWSHIP | 11 POSITIONS

The one-year clinical fellowship in body imaging consists of four-week clinical rotations on the core body services including CT, ultrasound, and MRI. Three elective rotations are available and can include rotations in image guided biopsies, cardiovascular imaging, musculoskeletal imaging, breast imaging, etc. Fellows will receive experience in all cross-sectional studies of the chest, abdomen, pelvis, and musculoskeletal system. Fellows will also receive training in vascular scanning, image-guided biopsies, CT colonography, and other procedures.

BODY MRI FELLOWSHIP | 4 POSITIONS

The Body MRI Fellowship provides a year of intensive training in clinical MRI across a wide range of diagnostic and therapeutic applications. Fellows are responsible for managing the clinical services, including protocols, initial interpretations, MR-guided procedures, scanner-side exam optimization and troubleshooting, translational research, and teaching. The service consists of thirty scanners across all vendors, which are 3T MRIs, including PET-MR scanners.

BREAST IMAGING FELLOWSHIP | 3 POSITIONS

Stanford's Breast Imaging Fellowship offers training in digital mammography with CAD; breast tomosynthesis; breast ultrasound; core biopsies and preoperative needle localization under ultrasound, stereotactic, tomosynthesis, and MR-guidance; interpretation of breast MRI for breast cancer and implants; a research program in contrast-enhanced mammography; and outcome analysis of new technology. Research time is provided during the fellowship for academic projects.

CARDIOVASCULAR IMAGING FELLOWSHIP | 2 POSITIONS

The Cardiovascular Imaging (CVI) Fellowship provides one year of training in noninvasive cardiovascular imaging using CT and MRI. Fellows receive detailed training in the principles and use of state-of-the-art multidetector row CT and cardiovascular MR imaging systems within the context of a busy clinical cardiovascular imaging service. Fellows study cardiovascular diseases in adults as well as in children thereby substantially enhancing the fellowship through a close working relationship with adult and pediatric cardiologists, surgeons, and interventional radiologists.

INTERVENTIONAL NEURORADIOLOGY FELLOWSHIP | 2 POSITIONS

The Interventional Neuroradiology fellowship is a key component of the Stanford Stroke Center providing a large number of referrals for intra-arterial thrombolysis, angioplasty, and aneurysm treatment. The Division is also an integral component of an international referral center for the treatment of arteriovenous malformations (AVMs) with a multimodality treatment program including charged-particle radiosurgery, microsurgery, and endovascular therapy.

INTERVENTIONAL RADIOLOGY FELLOWSHIP | 6 POSITIONS

The Interventional Radiology Fellowship experience encompasses the entire range of IR involving both vascular and nonvascular interventions. Fellows perform a wide variety of treatments including loco-regional tumor therapy, transplant and hepato-biliary interventions, angioplasty, catheter-directed thrombolysis, IVC filtration, venous reconstruction, vascular stenting, fibroid embolization, vascular anomaly ablation, pediatric interventions, TIPS, and aortic stentgrafting. The Interventional Radiology service is an integral component of the Vascular Center at Stanford.

MUSCULOSKELETAL IMAGING FELLOWSHIP | 3 POSITIONS

The key features of the one-year Musculoskeletal Imaging Fellowship include extensive involvement in musculoskeletal MRI with an emphasis on sports injuries and musculoskeletal ultrasound and CT. In addition, a moderate volume of plain radiographic studies, arthrograms, and tenograms are performed. Dedicated time for research is provided. Fellows are expected to participate actively in research with faculty radiologists as well as Stanford's world-renowned imaging physicists and engineers.

NEUROIMAGING FELLOWSHIP | 14 POSITIONS

The Neuroimaging Fellowship is designed to be a well-balanced academic training program that encompasses all of the basic and advanced clinical and research areas of both adult and pediatric neuroradiology. Neuroimaging fellows are exposed, during the course of the fellowship, to all imaging modalities used to evaluate neurologic disease, including CT, MRI, myelography, angiography, and ultrasound during the course of the fellowship. Fellows will also actively participate in state-of-the-art interventional neuroradiology procedures.

PEDIATRIC RADIOLOGY FELLOWSHIP | 5 POSITIONS

The Pediatric Radiology Fellowship is jointly sponsored by the Lucile Salter Packard Children's Hospital and Stanford University Hospital. The fellowship provides a comprehensive pediatric radiology imaging program utilizing state-of-the-art imaging technology, including two fluoroscopy suites, three ultrasound rooms, as well as 3T MRI, 1.5T MRI, and CT imaging suites. Fellows rotate through a series of services, including pediatric MR, pediatric CT, PET-CT, pediatric fluoroscopy, pediatric ultrasound, pediatric neuroradiology, nuclear medicine, interventional radiology, and general radiography.

THORACIC IMAGING FELLOWSHIP | 2 POSITIONS

The Thoracic Imaging Fellowship is designed to be a well-balanced academic training program that provides exposure to basic and advanced clinical applications in cardiothoracic imaging including lung cancer screening and cardiac imaging. Clinical training consists of rotations on chest (eight months), cardiovascular (three months), and thoracic interventional (one month) services. One day per week of research time is allotted.

Research Training Programs

NIH-Funded Training Programs

The Department of Radiology is home to six NIH-funded training and education programs, each reflecting specialized strengths of our highly regarded research divisions: Canary Center at Stanford for Cancer Early Detection, Integrative Biomedical Imaging Informatics at Stanford (IBIIS), Molecular Imaging Program at Stanford (MIPS), and the Radiological Sciences Laboratory (RSL). Through five of these programs, the department supports and trains, on average, 30 graduate and postdoctoral trainees each year encompassing a broad range of imaging related topics such as advanced cancer imaging, physics and instrumentation, molecular imaging, systems biology, and nanotechnology. The sixth and most recently funded program, the Canary CREST program, is the first and only program in the department targeted specifically for undergraduate students and is fully focused on early detection of cancer.

SCIT Program

Stanford Cancer Imaging Training Program

NIH/NCI 5 T32 CA009695 25

PIs: Sandy Napel, PhD and Bruce Daniel, MD

Program Manager: Sofia Gonzales, MS

The SCIT Program is a two-year program that offers a unique research opportunity in cancer imaging. Currently in its 25th year of training, the program, initially called the Advanced Techniques for Cancer Imaging and Detection Program, was designed and directed by Dr. Gary Glazer, former chair of the department. The goal of the program is to provide MD and PhD research fellows advanced training in cancer-related imaging research with a focus that is primarily driven by physics and technology development and application. Since its inception in 1992, the SCIT program has provided support for the training of more than 40 fellows.

CURRENT TRAINEES	MENTORS
Hamed Arami, PhD	Sanjiv Sam Gambhir, MD, PhD and Robert Sinclair, PhD
Joshua de Bever, PhD	Brian Rutt, PhD and Sanjiv Sam Gambhir, MD, PhD
Pooja Gaur, PhD	Kim Butts Pauly, PhD
Hersh Sagreiya, MD	Daniel Rubin, MD, MS and Juergen Willmann, MD
Siavash Yousefi, PhD	Lei Xing, PhD and Juergen Willmann, MD

SMIS Program

Stanford Molecular Imaging Scholars Program

NIH/NCI 2 T32 CA118681-12A1

PI: Craig Levin, PhD

Program Manager: Sofia Gonzales, MS

The SMIS Program is a three-year interdisciplinary postdoctoral training program at Stanford University. The centerpiece of the SMIS program is the opportunity for trainees to conduct innovative molecular imaging research that is co-mentored by faculty in complementary disciplines. The SMIS program, with its distinctive focus on biology and chemistry, is in its 12th year and has provided training and support for 31 fellows to date.

CURRENT TRAINEES	MENTORS
Joshua Cates, PhD	Craig Levin, PhD
Sayan Mullick Chowdhury, PhD	Juergen Willmann, MD
David Huland, PhD	Sanjiv Sam Gambhir, MD, PhD
Tae Jin Kim, PhD	Guillem Pratx, PhD
Justin Klein, PhD	Guillem Pratx, PhD
Jessica Klockow, PhD	Frederick Chin, PhD

TBI² Program

Training in Biomedical Imaging Instrumentation Program

NIH/NIBIB 5 T32 EB009653 07

PIs: Kim Butts Pauly, PhD and Norbert Pelc, ScD

Program Managers: Barbara Bonini and Marlys LeSene

The TBI² program, jointly led by faculty in Radiology and Bioengineering, offers unique multidisciplinary predoctoral research training in biomedical imaging technologies across all spatial scales, spanning magnetic resonance, computed tomography and radiography, optical imaging, ultrasound, PET, and hybrid imaging such as X-ray/MR and PET-MR, as well as image processing and analysis for diagnosis, radiation therapy, and basic science. Since recruitment began in 2010, the program has supported and trained 20 graduate students.

CURRENT TRAINEES	MENTORS
Dylan Black	Olav Solgaard, PhD
Ehsan Dadgar-Kiani	Jin Hyung Lee, PhD
Phillip DiGiacomo	Michael Zeineh, MD, PhD
Ningrui Li	Kim Butts Pauly, PhD
Elise Robinson	Sanjiv Sam Gambhir, MD, PhD
Christopher Sandino	Shreyas Vasanawala, MD, PhD

CSBS Program

Cancer Systems Biology Scholars Program

NIH/NCI 5 R25 CA180993 03

PI: Sylvia Plevritis, PhD and Garry Nolan, PhD

Program Manager: Theresa McCann

The CSBS program is a two-year postdoctoral training program at Stanford University focused on innovative, multidisciplinary cancer research education that seamlessly integrates experimental and computational biology to systematically unravel the complexity of cancer. The program brings together 36 Stanford faculty mentors from 19 departments or divisions bridging the Schools of Medicine, Engineering, and Humanities and Sciences. The CSBS Program has trained five inaugural scholars and completed candidate recruitment for the next trainee cohort that started on September 1, 2017.

CURRENT TRAINEES	MENTORS
Gina Bouchard, PhD	Sylvia Plevritis, PhD and Amato Giaccia, PhD
Roozbeh Dehghannasiri, PhD	Julia Salzman, PhD and Steven Artandi, MD, PhD
Aaron Horning, PhD	Michael Snyder, PhD and Christina Curtis, PhD
Henry Li, PhD	Edgar Engleman, MD, PhD and Sylvia Plevritis, PhD
Barzin Nabet, PhD	Max Diehn, MD, PhD, Andrew Gentles, PhD, and Rob Tibshirani, PhD

Cancer-TNT Program

Cancer-Translational Nanotechnology Training Program

NIH/NCI 5 T32 CA196585 02

PI: Jianghong Rao, PhD and Dean Felsher, MD, PhD

Program Manager: Billie Robles

The Cancer-TNT Program is a synergistic three-year postdoctoral training program bringing together 25 faculty and nine departments from the Schools of Medicine, Engineering, and Humanities and Sciences to train the next generation of interdisciplinary leaders in cancer nanotechnology research and clinical translation. Trainees complete coursework and research with two complementary mentors to bridge multiple disciplines such as chemistry, molecular biology, bioengineering, molecular imaging, nanoengineering, and clinical medicine to advance cancer nanotechnology translation research, diagnosis, and treatment.

CURRENT TRAINEES	MENTORS
Timothy Blake, PhD	Robert Waymouth, PhD and Paul Wender, PhD
Viola Chen, MD	Alice Fan, MD and Shan Wang, PhD
Ryan Davis, PhD	Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD
Arvin Gouw, PhD	Dean Felsher, MD, PhD and Richard Zare, PhD
Ashwin Ram, MD	Michael Snyder, PhD
Travis Shaffer, PhD	Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD

Canary CREST Program

Canary Cancer Research Education Summer Training Program

NIH/NCI 1 R25 CA217729 01

PIs: H. Tom Soh, PhD and Utkan Demirci, PhD

Program Manager: Stephanie van de Ven, MD, PhD

The Canary CREST Program, newly funded as of September 1, 2017, will recruit and train 25 undergraduate students each year in early cancer detection initiatives through a 10-week summer research program. This program, beginning June 1, 2018, is led by Drs. Tom Soh, Utkan Demirci, and Stephanie van de Ven, with a team of 28 mentors, all committed to research in early cancer detection. During the five-year award, the Canary CREST Program aims to train a total of 125 young scientists.

ARTS Program

Advanced Residency Training at Stanford Program

PI: Sanjiv Sam Gambhir, MD, PhD

Program Manager: Sofia Gonzales, MS

In addition to the NIH-funded training programs, Stanford is also home to the Advanced Residency Training at Stanford (ARTS) Program that offers residents and clinical fellows the opportunity to combine their clinical training with advanced research training to complete a PhD degree during or upon completion of residency or clinical fellowship. The program begins with one or more years of postgraduate clinical training, followed by research training in one of twenty graduate programs from the Schools of Medicine, Engineering, or Humanities and Sciences. Through the ARTS Program that provides individuals with the tools needed to move freely between the laboratory and the clinic, Stanford demonstrates its commitment to the emerging disciplines of translational medicine and precision medical care.

CURRENT TRAINEES	MENTORS
Stephen Chang, MD	Mark Krasnow, PhD
Asiri Ediriwickrema, MD	Ravi Majeti, MD, PhD
Deshka Foster, MD	Michael Longaker, MD
Geoff Krampitz, MD	Irving Weissman, MD
David Kurtz, MD	Sanjiv Sam Gambhir, MD, PhD
Eugene Richardson, MD	Andrew Zolopa, MD
Makeda Robinson, MD	Shirit Einav, MD

Graduating PhDs 2015–16

Matthew Bieniosek, PhD

Molecular Imaging Program at Stanford

Current Position:
PET Hardware Scientist, RefleXion Medical, Hayward, CA

Dissertation:
Electronic Readout Strategies for Silicon Photomultiplier-based Positron Emission Tomography Detectors

Sebastian Echegaray, PhD

Molecular Imaging Program at Stanford

Current Position:
Postdoctoral Scholar, Department of Radiology/IBIIS, Stanford University School of Medicine, Stanford, CA

Dissertation:
Efficient Characterization of Shapes and their Contents in Volume Data for Decision Support in Radiology

Diego Munoz Medina, PhD

Radiological Sciences Laboratory

Current Position:
Data Scientist, Radius Intelligence, San Francisco, CA

Dissertation:
Developing Subtype-Specific Stochastic Simulation Models of Breast Cancer Incidence and Mortality

Wendy Wei Ni, PhD

Radiological Sciences Laboratory

Current Position:
Data Scientist, Analytics, Facebook, Menlo Park, CA

Dissertation:
Quantitative Brain Tissue Oxygenation Mapping Using Magnetic Resonance Spin Relaxation

Brady Quist, PhD

Radiological Sciences Laboratory

Current Position:
Apple, Mountain View, CA

Dissertation:
Model-Based Artifact Correction in MRI

Bragi Sveinsson, PhD

Radiological Sciences Laboratory

Current Position:
Research Fellow, Massachusetts General Hospital, Boston, MA

Dissertation:
Quantitative Measurements and Artifact Correction Methods in Body Magnetic Resonance Imaging

Graduating PhDs 2016–17

Akshay Chaudhari, PhD

Radiological Sciences Laboratory

Current Position:
Postdoctoral Scholar, Department of Radiology/RSL, Stanford University School of Medicine, Stanford, CA

Dissertation:
Advances in Morphological and Quantitative Musculoskeletal MRI

Jingyuan Chen, PhD

Radiological Sciences Laboratory

Current Position:
Postdoctoral Fellow, Massachusetts General Hospital, Boston, MA

Dissertation:
Temporal Characteristics of Intrinsic Brain Activity Based on Functional Magnetic Resonance Imaging

Haisam Islam, PhD

Radiological Sciences Laboratory

Current Position:
MRI Software Engineer, HeartVista, Los Altos, CA

Dissertation:
Methods for High-Resolution Functional MRI

Rebecca Sawyer Lee, PhD

Radiological Sciences Laboratory

Dissertation:
Quantitative Brain Tissue Oxygenation Mapping Using Magnetic Resonance Spin Relaxation

Evan Levine, PhD

Radiological Sciences Laboratory

Current Position:
Senior Software Engineer, Magic Leap, Plantation, FL

Dissertation:
Data Sampling and Constrained Reconstruction for High-Dimensional MRI

Uchechukwuka Monu, PhD

Radiological Sciences Laboratory

Current Position:
Consultant, Boston Consulting Group, San Francisco, CA

Dissertation:
Visualization and Evaluation Tools of Quantitative MRI in an ACL-Injured Population

Qiyuan Tian, PhD

Radiological Sciences Laboratory

Current Position:
Postdoctoral Research Fellow, Martinos Center for Biomedical Imaging, Massachusetts Hospital, Boston, MA

Dissertation:
Advancing Diffusion-Weighted Magnetic Resonance Imaging Methods for Neuronal Fiber Mapping

Umit Yoruk, PhD

Radiological Sciences Laboratory

Current Position:
Senior Sofware Engineer, Oracle, San Bruno, CA

Dissertation:
Quantification of Glomerular Filtration Rate using DCE-MRI in Children

Trainee Honors and Awards

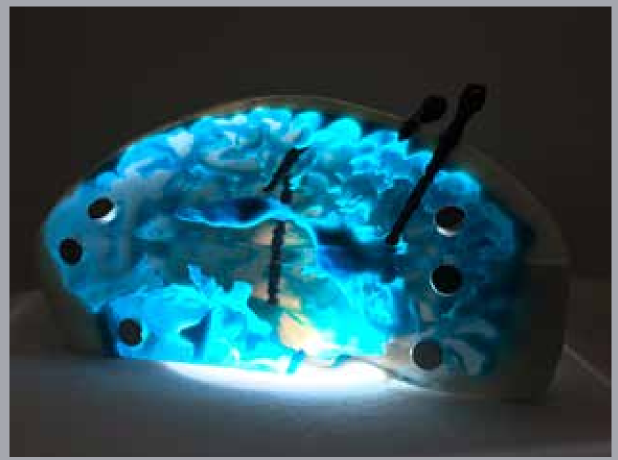
Amin Aalipour, MD, PhD	2017 Named Paul & Daisy Soros Fellow
Maryam Ahighi, PhD	2016 RSNA Trainee Research Prize Award
Hamed Arami, PhD	2016 Selected to present at the University of Washington's "Distinguished Young Scholars Seminar" series
Hao Chen, PhD	2017 Young Investigator Award (2nd place) in the Chinese American Society of Nuclear Medicine and Molecular Imaging (CASNMMI)
Jingyuan Chen, PhD	2016 ISMRM Summa Cum Laude Merit Award
Jang-Hwan Choi, PhD	2016 Orthopedic Research Society (ORS) New Investigator Recognition Award
Ahmed El Kaffas, PhD	2016 Poster Award, World Molecular Imaging Congress (WMIC) 2017 Bay Area Chapter AAPM Young Investigator Best Presentation Award
Audrey Fan, PhD	2016 ISMRM Summa Cum Laude Merit Award 2017 Elected as Trainee Representative of the PET-MRI Study Group (ISMRM and SNMMI)
Jia Guo, PhD	2017 ISMRM Magna Cum Laude Merit Award
Anshul Hadipur, MD	2017 ISMRM Magna Cum Laude Merit Award
Anna Saller Karmann, MD, PhD	2016 Featured Paper Award, Cardiovascular and Interventional Radiology Society of Europe (CIRSE) 2016 RSNA Top-Rated Scientific Abstract Award
Jessica Klockow, PhD	2016 American Chemical Society CIBA/YCC Young Scientist Award
Feliks Kogan, PhD	2017 Young Investigator Cum Laude Award Winner
Kai Li, PhD	2016 Poster Award, World Molecular Imaging Congress (WMIC)
Wilson Lin, MD	2016 RSNA Trainee Research Prize Award
Michael Mastanduno, PhD	2016 Poster Award, World Molecular Imaging Congress (WMIC)
Aaron Reposar, MD	2016 Invitation to the SIR Grassroots Leadership Program
Alexander Sheu, MD	2016 Stanford Society of Physician Scholars (SSPS) Grant 2016 The Stanford University Radiology Residency Program Etta Kalin Moskowitz Fund Research Award 2016 Stanford Medicine Teaching and Mentoring Academy Innovation Grant
Subashini Srinivasan, PhD	2016 ISMRM Junior Fellow
Riccardo Stara, PhD	2017 ISMRM Magna Cum Laude Merit Award
Ophir Vermesh, MD, PhD	2016 Best Talk Award at the SURPAS Postdoctoral Research Symposium 2016 Best Poster at IEEE Micro and Nanotechnology in Medicine 2017 Bio-X Poster Award
Hans Weber, PhD	2017 ISMRM Junior Fellow
Martin J. Willemink, MD, MSc, PhD	2016 European Radiology Most Cited Paper Award at the European Society of Radiology 2016 Frederick Philips Prize for Clinical Imaging at the Dutch Society of Radiology 2016 RSNA Cum Laude Award for Educational Exhibit
Katherine Wilson, PhD	2017 Molecular Imaging Young Investigator Prize
Jinghang Xie, PhD	2017 Molecular Imaging Young Investigator Prize
Daehyun Yoon, PhD	2016 ISMRM Magna Cum Laude Merit Award

*Please see Sponsored Research for projects awarded funding

Feature

3DQ Lab

The Stanford Radiology 3D and Quantitative Imaging Laboratory (3DQ Lab) supports the mission of the department by developing and providing alternative visualizations and quantitative analysis of images for Stanford's patients. Since 1996, the 3DQ Lab has steadily grown and now consists of 15 technologists performing 3D reconstruction and quantification for many clinical entities, including Stanford Health Care and Lucile Packard Children's Hospital. Leadership of the 3DQ Lab includes Dr. Sandy Napel (Scientific Director), Dr. Dominik Fleischmann (Clinical Director), Dr. Roland Bammer (Technical Director), and Mr. Shannon Walters (Executive Manager).



A 3D-printed model of the brain created by merging CT and MRI data for a study on epilepsy. The black probes seen in the image are used to localize seizure activity in the brain. The round black dots are magnets used to assemble other parts of the model.

HIGHLIGHTS INCLUDE:

3D Printing: Over the last four years, the 3DQ Lab has steadily gained proficiency in 3D printing processes and policies, with a focus on scaling to meet future demands in healthcare. With several small 3D printers, the lab has been able to improve communication and influence the surgical planning process. In addition to serving emerging clinical needs, several researchers have been leveraging the skills and resources available in the 3DQ Lab for creating patient-specific models for pre-surgical/ interventional planning.

Neuroimage Processing: Starting in 2014, the 3DQ Lab began processing functional Magnetic Resonance Imaging (fMRI) examinations for radiologists, freeing up their time for other activities. In 2017, the Lab added Diffusion Tensor Imaging processing which further frees up radiologists' time and helps standardize the protocol.

Prostate Cancer Staging: Ultrasound guided prostate biopsy is limited because of its poor differentiation of normal from suspicious tissue, which is better accomplished by MRI. The 3DQ Lab segments images of the prostate from MRI scans for fusion with ultrasound images during biopsy, allowing accurate needle guidance to suspicious regions. This process has improved workflows within the Department of Urology and has nearly doubled the number of biopsies possible.

Percutaneous Pulmonary Valve Replacements: This is another intervention that benefits from precise measurements based on images made by technologists in the 3DQ Lab. This work builds upon the lab's history of supporting Transcatheter Aortic Valve Replacements for over 1,000 patients since 2008.

Front row L-R: Linda Horst, Sandy Napel, Domink Fleischmann, Keshni Kumar; Middle row L-R: Chris Letrong, Kristy Bogart, Rhea Liang, Marc Sofilos; Back row L-R: Kyle Gifford, Jennifer Stege, Jean Sullivan, Shannon Walters

Standardized Tumor Response Assessments: Teaming up with Dr. Christoph Becker, the 3DQ Lab is now providing tracking and standard reports of measurements of tumor response to therapy. This is one of the fastest growing segments of the 3DQ Lab, and could double the number of patients processed in a given year.

Prediction Model for Acute Type-B Dissections: Spurred by recent trials showing mixed outcomes between intervention and medical management, the research arm of the 3DQ Lab is developing prediction models for progression based on imaging features such as outflow vasculature and pre-existing conditions.

Education: In addition to clinical applications, the 3DQ Lab is an excellent resource for medical professionals to obtain clinical training in 3DQ image post-processing and quantitative imaging methods. A variety of educational opportunities are available for Stanford medical affiliates (residents and fellows) as well as technologists, radiologists, and imaging specialists from domestic and international medical imaging communities. The 3DQ Lab also hosts two types of Visiting Fellowships in the department.

CLINICAL LEADERSHIP

Sanjiv Sam Gambhir, MD, PhD
Chair, Department of Radiology

David Larson, MD, MBA
Vice Chair, Education and Clinical Operations

Juergen Willmann, MD
Vice Chair, Strategy, Finance, and Clinical Trials
Division Chief, Body Imaging

Richard Barth, MD
Radiologist-in-Chief, LPCH

Christopher Beaulieu, MD, PhD
Division Chief, Musculoskeletal Imaging

Wendy DeMartini, MD
Division Chief, Breast Imaging

Dominik Fleischmann, MD
Division Chief, Cardiovascular Imaging

Lawrence "Rusty" Hofmann, MD
Division Chief, Interventional Radiology

Andrei Iagaru, MD
Division Chief, Nuclear Medicine and Molecular Imaging

Curtis Langlotz, MD, PhD
Associate Chair, Information Systems

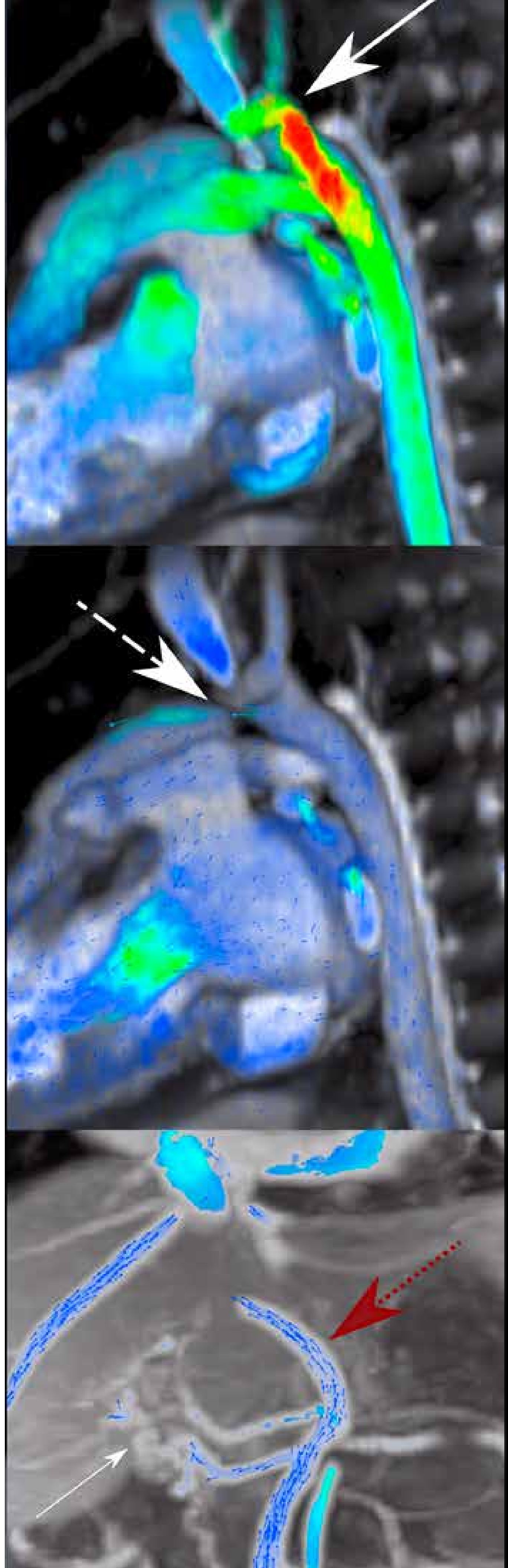
Ann Leung, MD
Associate Chair, Clinical Affairs
Division Chief, Thoracic Imaging

Payam Massaband, MD
Associate Chair, VA Palo Alto Health Care System

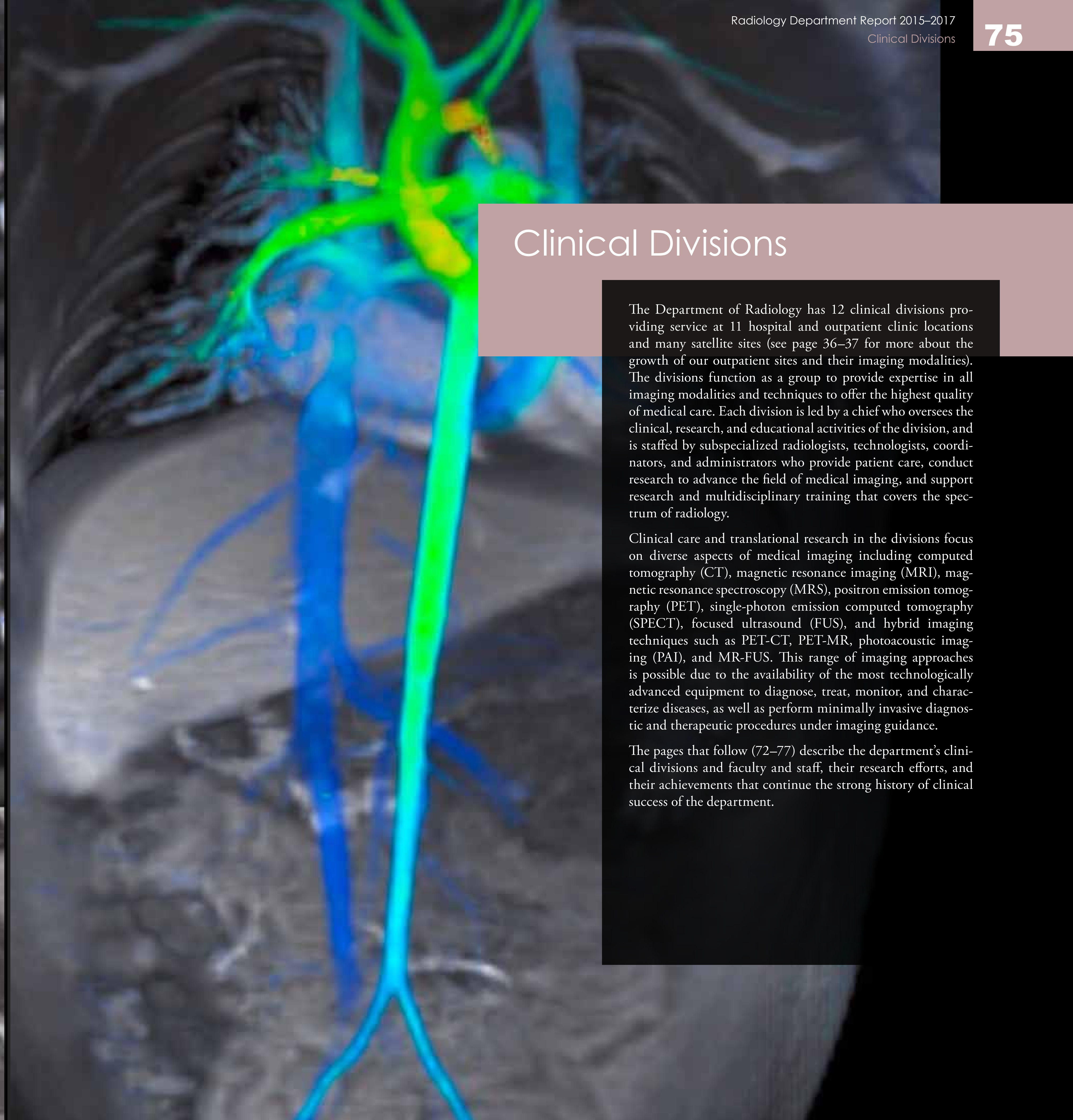
George Segall, MD
Division Chief, VA Nuclear Medicine

Shreyas Vasanawala, MD, PhD
Division Chief, Body MRI

Max Wintermark, MD, MAS, MBA
Division Chief, Neuroimaging and Neurointervention



MRI on an infant shows abnormally narrow aorta and resulting jet of flow (arrow), abnormal flow of oxygenated blood to the lungs (dashed arrow), and abnormal bypassing of blood with nutrients (red arrow) from the bowel to the heart—instead of the liver.



Clinical Divisions

The Department of Radiology has 12 clinical divisions providing service at 11 hospital and outpatient clinic locations and many satellite sites (see page 36–37 for more about the growth of our outpatient sites and their imaging modalities). The divisions function as a group to provide expertise in all imaging modalities and techniques to offer the highest quality of medical care. Each division is led by a chief who oversees the clinical, research, and educational activities of the division, and is staffed by subspecialized radiologists, technologists, coordinators, and administrators who provide patient care, conduct research to advance the field of medical imaging, and support research and multidisciplinary training that covers the spectrum of radiology.

Clinical care and translational research in the divisions focus on diverse aspects of medical imaging including computed tomography (CT), magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS), positron emission tomography (PET), single-photon emission computed tomography (SPECT), focused ultrasound (FUS), and hybrid imaging techniques such as PET-CT, PET-MR, photoacoustic imaging (PAI), and MR-FUS. This range of imaging approaches is possible due to the availability of the most technologically advanced equipment to diagnose, treat, monitor, and characterize diseases, as well as perform minimally invasive diagnostic and therapeutic procedures under imaging guidance.

The pages that follow (72–77) describe the department's clinical divisions and faculty and staff, their research efforts, and their achievements that continue the strong history of clinical success of the department.

Front row L-R: Nayeli Morimoto, Bruce Daniel, Juergen Willmann, Michael Federle, Brooke Jeffrey, Terry Desser, Andrew Shon;
Back row L-R: Edward Lo, Vol Van Dalsem, Russell Stewart, Andreas Loening, Peter Poullos, Aya Kamaya, Bhavik Patel, Eric Olcott

Body Imaging

Juergen Willmann, MD

The Body Imaging Division consists of 15 nationally and internationally renowned faculty, seven adjunct faculty, and 11 body fellows who are specialized in the interpretation of diseases of the abdomen and pelvis, as well as additional body parts such as the thyroid, carotid, and peripheral venous system. With experts in computed tomography, magnetic resonance imaging, ultrasound, molecular imaging, X-ray, and fluoroscopy, our division is committed to training the next generation of body radiologists while delivering cutting-edge clinical care. The breadth of experience among the faculty is reflected in the wide range of academic pursuits enjoyed by the division, ranging from clinical assessment of dual-energy and low dose CT protocols, novel pulse sequences in MRI, molecular imaging with ultrasound and photoacoustic technologies, ultrasound spectroscopy, hyperpolarized MR spectroscopy, as well as imaging-guided delivery of novel therapeutics, such as microRNAs, into liver cancer in preclinical animal models.

ACHIEVEMENTS

• Dr. Willmann: 2016 SAR Best Translational Science Paper award; Dr. Daniel: 2017 ISMRM 2nd place Best Interventional Study Group Presentation Award; Dr. Kamaya: 2016 ARRS Bronze Award Education Exhibit and winner of the 2016 SRU Unknown Case Competition.

• Published first-in-human clinical trial in breast and ovarian cancer patients using a molecularly-targeted ultrasound contrast agent.

• Funded to develop and test novel imaging approaches and image-guided drug delivery strategies for improved cancer therapy.

• Multiple patent disclosures filed with the Office of Technology and Licensing.

Front row L-R: Andreas Loening, Pejman Ghanouni, Shreyas Vasanawala, Jamil Shaikh, Kim Vu, Albert Roh, Angela Fast, Marissa Lee;
Back row L-R: Robert Herfkens, Joseph Cheng, Michael Muelly, Brian Hargreaves, Stephanie Chang, Bruce Daniel

Body MR Imaging

Shreyas Vasanawala, MD, PhD

The Body MR Division aims to provide outstanding patient care, lead innovations in the practice of Body MR, and train the next generation of clinician scientists, while developing a tight link between diagnosis and therapy for highly personalized care. We provide services that are personally tailored for each patient and delivered with state-of-the-art MRI technology and highly trained staff. Most exams use techniques developed and uniquely available here at Stanford. Faculty members are internationally recognized experts in body MRI, and have deep experience developing new methods to improve diagnostic precision. Body MRI research at Stanford is fostered by close collaboration and friendships between clinicians and research scientists in the Department of Radiology, the University, and throughout the Bay Area.

ACHIEVEMENTS

• Launched clinical PET-MRI program.

• Introduced essential tremor treatment program.

• Launched new services in Emeryville.

• Recognized as MRI Guided Focus Ultrasound Center of Excellence.

Front row L-R: Bruce Daniel, Wendy DeMartini, Debra Ikeda;
Back row L-R: Audra Brunelle, Sunita Pal, Lisa Schmelzel, Xin Ye

Breast Imaging

Wendy DeMartini, MD

The Breast Imaging Division provides compassionate and evidence-based patient care, conducts research, and trains future leaders in the field. Our faculty are internationally recognized experts in mammography and breast MRI. All mammography studies are performed using 3D digital breast tomosynthesis, and all breast MRI studies are performed using 3T magnets. For breast surgery lesion localization, we offer a wireless non-radioactive method done prior to surgery to provide a better experience for patients and surgeons. We will soon install mammography room "sensory suites" that allow patients to select a sensory ambiance (sight-scent-sound) to improve their visit. Our research includes (1) investigating factors contributing to false negative screening mammograms, (2) understanding comparative effectiveness of breast imaging tests to guide personalized care, (3) improving breast MRI techniques using high temporal resolution and novel sequences, and (4) developing a mixed/augmented reality breast cancer surgery system.

ACHIEVEMENTS

• We conduct mammography studies with 3D-like digital breast tomosynthesis and synthetic 2D techniques to improve diagnostic accuracy while using only "single mammogram" radiation dose.

• We offer breast surgery localization with a wireless non-radioactive method that can be performed ahead of surgery.

• We emphasize performing breast biopsies on the same day as diagnostic imaging, decreasing the time to diagnosis, and requiring fewer patient visits.

• Dr. Wendy DeMartini was elected President of the Society of Breast Imaging.

Front Row L-R: Robert Herfkens, Hans-Christoph Becker, Frandics Chan
Back Row L-R: Arash Bedayat, Murad Bandali, Dominik Fleischmann

Cardiovascular Imaging

Dominik Fleischmann, MD

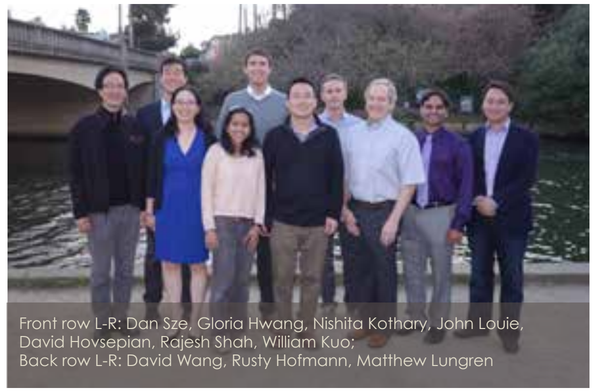
The Cardiovascular Imaging (CVI) Division uses dedicated image post-processing techniques to provide unprecedented 3D and 4D visualization and quantitation of cardiovascular anatomy and pathology to establish an accurate diagnosis and facilitate treatment planning for surgical or endovascular procedures, some of which are pioneered at and unique to Stanford. Our internationally renowned imaging experts in cardiovascular imaging have extensive clinical and research expertise in CT, MRI, and nuclear medicine imaging technology applied to the clinical management of acquired and congenital cardiovascular diseases. Also, with a deep understanding of radiation exposure, we are highly trained leaders in promoting the latest dose reduction techniques, thereby allowing us to provide the best quality images under the most advanced conditions for our patients, one at a time.

ACHIEVEMENTS

• Coronary calcium score screening to modify risk factors and stabilize current disease state.

• Coronary CTA (CCTA) allows coronary artery imaging without coronary catheterization.

• Working together as a team of radiologists, basic scientists, and technologists to reduce radiation exposure according to international safety principles of ALARA (As Low As Reasonably Achievable).



Front row L-R: Dan Sze, Gloria Hwang, Nishita Kothary, John Louie, David Hovsepian, Rajesh Shah, William Kuo;
Back row L-R: David Wang, Rusty Hofmann, Matthew Lungren

Interventional Radiology

Lawrence "Rusty" Hofmann, MD

Interventional Radiology (IR) offers the entire range of vascular and non-vascular image-guided procedures. We are experts in treating endovascular arterial disease, stenting (expanding) occluded blood vessels, endograft repair of aneurysms, deep vein thrombosis (DVT), and chronic venous occlusions. We also specialize in image-guided tumor treatments including chemoembolization, radiofrequency ablation, cryoablation, NanoKnife ablation, and radioembolization. Our group also provides services to alleviate pelvic pain due to symptomatic fibroids and gonadal vein embolization for pelvic congestion syndrome. As pioneers of minimally invasive surgery, we employ advanced imaging techniques to eliminate the need for open surgery and allow shorter recovery times.

ACHIEVEMENTS

• Dr. William Kuo featured on NBC Nightly News with Lester Holt, related to his expertise in IVC filters.

• Opening an advanced IR practice, staffed by three IR physicians, at Valley Care, October 2017.

• Dr. Rusty Hofmann, Global PI of the first FDA-approved trial for venous stenting, completed enrollment of 273 patients on October 31, 2016.

• The Stanford IR Residency matched its inaugural class in March 2016.

L-R: Geoffrey Riley, Kathryn Stevens, Sandip Biswal, Christopher Beaulieu, Joseph DeMartini, Amelie Lutz, Garry Gold

Musculoskeletal Imaging

Christopher Beaulieu, MD, PhD

The Musculoskeletal Division provides state-of-the-art imaging services and special interventions for patients with bone, joint, and soft tissue disorders. Over 65,000 examinations are performed annually including radiography, MRI, CT, ultrasound, and injection/aspiration procedures. Seven full time faculty at Stanford and three faculty at the VA Palo Alto oversee resident and fellow trainees. Research efforts include the development of efficient imaging methods for assessment of arthritis, imaging around metallic implants, imaging of peripheral pain, MR neurography, and bioinformatics applications to bone tumor diagnosis. Additional cross-specialty research includes targeted microbubble studies for early detection of ovarian cancer and development of machine learning and artificial intelligence applications to liver lesions.

ACHIEVEMENTS

• Expansion of peripheral nerve imaging with our "MR neurography" service.

• Pre-clinical implementation of PET-MRI for imaging of peripheral pain and other musculoskeletal disorders.

• Ongoing imaging and interventional services for Stanford Athletics and the San Francisco 49ers.

• Established a prototype user interface to assist radiologists with bone tumor diagnosis.

• Reached over 6,500 subscribers on YouTube channel with MSK educational videos.

1st row L-R: Greg Zaharchuk, Mingming Ma, Kristen Yeom, Nancy Fischbein, Christine Kim, Anejza Chukus, Max Wintermark; 2nd row L-R: Amar Patel, Louis Golden, Alexis Crawley, Michael Iv, Hans Bakken; 3rd row L-R: Huy Do, Young Kim, Mrudula Penta; 4th row L-R: Tarik Massoud, Jeremy Heit, Kevin Hsu, Raag Airan; 5th row L-R: Neil Thakur, Amin Saad; 6th row L-R: Hisham Dahmoush, Eric Tranvinh, Michael Zeineh, Bryan Lanzman; 7th row L-R: Ruchir Chaudhari, Hannes Kroll

Neuroimaging and Neurointervention

Max Wintermark, MD, MAS, MBA

The Neuroimaging and Neurointervention Division consists of 17 world-renowned faculty and 16 fellows who specialize in interpreting imaging studies of the brain, spine, and head and neck. We offer minimally invasive treatment of cerebral aneurysms and other cerebral vascular malformations, stenting of carotid arteries, vertebroplasty and image-guided biopsy. We have unique expertise in advanced neuroimaging techniques including dual-energy CT, functional MRI, DTI and tractography, spectroscopy, and perfusion imaging. We are the only Bay Area center to offer the brain "stress test", advanced blood flow imaging to evaluate cerebrovascular reserve. We offer rapid, dedicated stroke MR and CT imaging to differentiate between completed stroke and "at-risk" tissue, with automated decision support software that has been validated in multicenter trials.

ACHIEVEMENTS

• Contribution to a facility for integrated neurological imaging (CT, MRI, PET-MR) and care, in collaboration with colleagues in Neurology and Neurosurgery.

• Implementation of Visualase-combined neurosurgical/neuroradiological MRI procedure for minimally invasive brain surgery.

• Multiple NIH and industry-sponsored clinical trials, in diverse areas such as acute stroke, chronic fatigue syndrome, and traumatic brain injury.

• Combined PET-MR imaging of cerebral blood flow using ^{15}O water.

1st row L-R: Sonya Park, Luan Nguyen, Vinh Nguyen, Paulo Castaneda, Phillip Alvarado, Lucia Baratto; 2nd row L-R: Tomomi Nobashi, Hong Song, Larissa Bastos, Cindy Chan, Kim Ramos, Mariam Ali, Nora Gurevich, Andrei Iagaru; 3rd row L-R: Chris Fuji, Caitlyn Harrison, Negin Hatami, Claudia Zacharias, Ceatrin Fello, John Valenton, Tina Huang, Katherine Giroux, Julie Kulm; 4th row L-R: Akira Toriihara, Sarina Smith, Erik Mittra, Craig Levin, Zachary Leonard, Matthew Theilman, Stephen Dinning, Shyam Srinivas

Nuclear Medicine and Molecular Imaging

Andrei Iagaru, MD

The Nuclear Medicine and Molecular Imaging Division at Stanford University offers a broad range of capabilities including SPECT, SPECT-CT, PET-CT, PET-MR and targeted radionuclide therapy. In line with the goal of advancing patient care, we actively participate in translational research, as well as state-of-the-art clinical imaging. We make every effort to support collaborations across academia, as well as with industry. We are committed to improving health through excellence in image-based patient care, research and education. We also offer the first ever combined Nuclear Medicine and Diagnostic Radiology residency training program in the U.S.

ACHIEVEMENTS

• 2016 Aunt Minnie Radiology Image of the Year: From paper "Pilot Comparison of ^{68}Ga-RM2 PET and ^{68}Ga-PSMA-11 PET in Patients with Biochemically Recurrent Prostate Cancer" published in the April 2016 issue of The Journal of Nuclear Medicine.

• First installations worldwide of GE SIGNA PET-MRI and GE Discovery MI PET-CT, moving PET technology from photomultiplier tubes to silicon photomultipliers.

• Targeted radionuclide therapy center for thyroid, prostate, and neuroendocrine tumors.

• Comprehensive prostate cancer imaging program including PSMA and bombesin targets.

1st row L-R: Heike Daldrup-Link, Richard Barth, Kristen Yeom, Shreyas Vasanawala; 2nd row L-R: Francis Blankenberg, Evan Zucker. Beverly Newman; 3rd row L-R: Frandics Chan, Hans Ringertz, Ralph Lachman, Erika Rubesova; 4th row L-R: Hisham Dahmoush, David Larson, Quan La, Glen Seidel; 5th row L-R: Jeremy Dahl, Avnesh Thakor, Jared Issacson, Matt Lungren

Pediatric Imaging

Richard Barth, MD

The Pediatric Radiology Division aims to improve the health of children through excellence in clinical imaging and image-guided diagnosis and therapy, translation of pediatric-specific innovations into clinical practice, and the education of future leaders in pediatric radiology. Pediatric Radiology at LPCH offers a comprehensive program that works every day to improve the health of children through the application of state-of-the-art technology. Children are not small adults and present unique challenges including different physiology, small anatomy, and radiation sensitivity. The pediatric radiology faculty are internationally recognized and have collaboratively developed safe, minimally invasive, non-radiation, high resolution imaging methods to benefit the care of children.

ACHIEVEMENTS

• Validated a deep neural network learning model to assess bone age on pediatric hand radiographs. SPR 2017 Annual Mtg: Caffey award for best research paper (Larson, Chen, Lungren, Halabi, Langlotz).

• Diagnosis of stress injuries in fingers of adolescent competitive rock climbers: Evaluation by ultrasound and MRI. SPR 2017 Annual Mtg: Most Promising Investigator award paper (Garcia, Jaramillo, Rubesova).

• Validation of ultrasound contrast cystography as an alternative to radiographic voiding cystourography (Emerson, Rubesova, Kennedy, Barth).

• Whole Body PET-MR investigation as an alternative to PET-CT to reduce radiation exposure.

• Development of printed flexible MRI coils as a more comfortable high resolution coil alternative for children (Vasanawala).

• Combined fMRI and MR Tractography for pre-surgical planning of brain tumor resections in children to minimize neurologic deficit (Yeom).

L-R: Matthew Muranaka, Charles Lau, Roberta Brissette, Ann Leung, Henry Guo.

Thoracic Imaging

Ann Leung, MD

The Thoracic Imaging Division aims to sustain and improve health through high-quality, state-of-the-art imaging of the chest. The division expanded with the arrival of a new faculty member, Dr. Emily Tsai and the addition of a second thoracic imaging fellow. As part of the daily provision of clinical care, our fellowship-trained thoracic radiologists work closely with referring physicians including pulmonologists, oncologists, and surgeons to enable multidisciplinary care that directly benefits patients. The division's educational efforts range from the teaching of medical students and housestaff to community outreach efforts on the indications and benefits of low-dose CT screening for lung cancer. In recent years, our research has focused on optimization of CT techniques for nodule evaluation and determining barriers to entry into a CT lung cancer screening program for the medically underserved.

ACHIEVEMENTS

• Dr. Henry Guo was awarded a Society of Thoracic Radiology seed grant for his project "Assurance of subsolid pulmonary nodule visualization by low-dose CT, facilitated by 3D printing."

• Dr. Ann Leung served as President of the Society of Thoracic Radiology (2016–2017).

• Dr. Leung is a co-author of the 2017 Fleischner Guidelines for Management of Incidental Pulmonary Nodules.

• Implementation and growth of CT clinical applications of dynamic airways evaluation and quantitative lung analysis for bronchiolitis obliterans.

Front row L-R: Charles Lau, Eric Tranvinh, Lewis Shin, Eric Olcott, Christine Ghatan, Christopher Parham, Sachin Malik, Bao Do, Payam Massaband; Back row L-R: Michelle Nguyen, Stephanie Chang, Rajesh Shah, Ali Tahvildari, Katherine To'o

VA Radiology

Payam Massaband, MD

The VA Palo Alto Health Care System is a flagship of the U.S. Department of Veterans Affairs for clinical care, teaching, and maintains one of the top three research programs in the VA. It is a large, multi-specialty tertiary care center with a 900+ bed system, consisting of three inpatient facilities and eight outpatient clinics throughout northern California and the Bay Area. There are multiple expansion projects underway, with over $1 billion in capital projects planned over the next decade. As a major part of the expansion program, construction continues on a new radiology department, projected to open in 2018. The VA Palo Alto serves more than 85,000 veterans, including patients with polytrauma; multi-organ system disease; and traumatic brain and spinal cord injuries, clinical needs that drive the significant collaborations among faculty and staff at the VA Palo Alto, Stanford Hospital, and Stanford University.

ACHIEVEMENTS

• Opening of the new Gourley Clinic in Monterey, serving veterans and active duty personnel and their families.

• Continued expansion of services offered at the VA Palo Alto Health Care System, with mammography scheduled to begin in late 2017. PET-MRI and high gradient MRI systems will be installed in the new department.

• Three of our VA radiologists were recognized by the Stanford University Radiology Residency Program for their excellence in teaching in 2016: Dr. Charles Lau received the Associate Faculty Teaching Award, Dr. Ali Tahvildari received the Assistant Faculty Teaching Award, and Dr. Patrick Lee received the Adjunct Faculty Teaching Award.

Front row L-R: Rodney Rodriguez, Clarita Domingo, Christine Keeling Taylor, Minal Vasanawala, Kelli Monteforte, Jen-Shi Liu, Ronni Norte; Back row L-R: Joanne Delan, Kent Hutchings, George Segall, Wendy Logan, Anthony Academia, Ken Luong, Rick Huntington, Milton Johnson

VA Nuclear Medicine

George Segall, MD

VA Nuclear Medicine provides a full range of diagnostic and therapeutic procedures using radionuclides, including general nuclear medicine, PET-CT, SPECT-CT, and cardiac stress tests. Radionuclide therapy includes NaI^{131} for thyroid disorders, and Ra^{223} dichloride for prostate cancer metastases to bone. We also work with Interventional Radiology providing Y^{90} microsphere therapy for liver tumor ablation. Nuclear Medicine also supports research projects in cardiac imaging and neuroimaging. We are also a tertiary referral center for PET-CT and other advanced imaging procedures. Equipment includes one PET-CT, three SPECT-CTs, and two bone densitometry scanners. We train radiology residents, nuclear medicine residents, and cardiology fellows. We are also the only VHA nuclear medicine technologist training program, and one of only two training programs in Northern California.

ACHIEVEMENTS

• VA tertiary referral center for PET-CT scanning in Northern California.

• Only VA-based training program for nuclear medicine technologists in the United States.

• Training center for Stanford cardiology fellows in nuclear cardiac imaging.

RESEARCH LEADERSHIP

Sanjiv Sam Gambhir, MD, PhD
Chair, Department of Radiology

Garry Gold, MD
Vice Chair, Research and Administration

Juergen Willmann, MD
Vice Chair, Strategy, Finance, and Clinical Trials

Kim Butts Pauly, PhD
Director, RSL

Sandy Napel, PhD
Co-Director, IBIIS

Sylvia Plevritis, PhD
Co-Director, IBIIS

Research Divisions

The Department of Radiology continues to make significant progress in research. During FY17, more than $55 million in sponsored funding was awarded to the department's research and clinical divisions. The resulting research accomplishments reflect a deep and growing commitment to elucidating the underlying physiologic processes of disease, developing new methodologies and therapies to improve patients' lives, and to educating and training the next generation of interdisciplinary scientists. Faculty leading sponsored projects in the department include experts in the fields of magnetic resonance imaging (MRI), ultrasound, X-ray, computed tomography (CT), positron emission tomography (PET), single-photon emission computed tomography (SPECT), spectroscopy, chemistry, molecular imaging, genomics/proteomics, bioinformatics, and computational sciences.

The following pages summarize the research carried out in investigative laboratories and groups within the research divisions in the department.

I. Canary Center at Stanford for Cancer Early Detection

II. Integrative Biomedical Imaging Informatics at Stanford (IBIIS)

III. The Molecular Imaging Program at Stanford (MIPS)

IV. The Radiological Sciences Laboratory (RSL)

V. Precision Health and Integrated Diagnostics (PHIND) Center at Stanford

Researchers in the department include faculty members, visiting scholars, staff scientists, postdoctoral fellows, and graduate and undergraduate students who actively collaborate with colleagues across Stanford, at affiliated institutions, other research institutions, industry partners, and foundations. Our collaborations span broadly across the Stanford campus, the United States, and reach out internationally.

DIVISION LEADERSHIP

Sanjiv Sam Gambhir, MD, PhD
Stephanie van de Ven, MD, PhD
Mark Stolowitz, PhD

SELECTED FUNDING

The Canary Foundation

Center for Cancer Nanotechnology Excellence for Translational Diagnostics (CCNE-TD). NIH/NCI 5 U54 CA199075 03 (Gambhir/Wang)

Stanford Molecular and Cellular Characterization Laboratory. NIH/NCI 5 U01 CA196387 03 (Brooks)

Canary Cancer Research Education Summer Training (Canary CREST) Program. NIH/NCI 1 R25 CA217729 01 (Soh/Demirci)

SELECTED PUBLICATIONS

Willmann JK, Bonomo L, Carla Testa A, Rinaldi P, Rindi G, Valluru KS, Petrone G, Martini M, Lutz AM, Gambhir SS. Ultrasound Molecular Imaging With BR55 in Patients With Breast and Ovarian Lesions: First-in-Human Results. Journal of Clinical Oncology, 2017 Jul 1; 35(19):2133–2140. PMCID: PMC5493049.

Wang J, Yu J, Yang Q, McDermott J, Scott A, Vukovich M, Lagrois R, Gong Q, Greenleaf W, Eisenstein M, Ferguson BS, Soh HT. Multiparameter Particle Display (MPPD): A Quantitative Screening Method for the Discovery of Highly Specific Aptamers. Angewandte Chemie (International ed. In English), 2017 Jan 16; 56(3):744–747. PMCID: PMC5225111.

Hori SS, Lutz AM, Paulmurugan R, Gambhir SS. A Model-Based Personalized Cancer Screening Strategy for Detecting Early-Stage Tumors Using Blood-Borne Biomarkers. Cancer Research, 2017 May 15; 77(10):2570–2584.

Park SM, Wong DJ, Ooi CC, Kurtz DM, Vermesh O, Aalipour A, Suh S, Pian KL, Chabon JJ, Lee SH, Jamali M, Say C, Carter JN, Lee LP, Kuschner WG, Schwartz EJ, Shrager JB, Neal JW, Wakelee HA, Diehn M, Nair VS, Wang SX, Gambhir SS. Molecular Profiling of Single Circulating Tumor Cells From Lung Cancer Patients. Proc. Natl. Acad. Sci. U.S.A., 2016 Dec 27; 113(52): E8379–E8386. PMCID: PMC5206556.

Baday M, Calamak S, Durmus NG, Davis RW, Steinmetz LM, Demirci U. Integrating Cell Phone Imaging with Magnetic Levitation (i-LEV) for Label-Free Blood Analysis at the Point-of-Living. Small, 2016 Mar 2; 12(9):1222–1229. PMCID: PMC4775401.

Micro-environmental forces lead to spatial patterning of benign (green) and malignant (red) cancer cells within a tumor. Image courtesy of Mallick lab.

Canary Center at Stanford for Cancer Early Detection

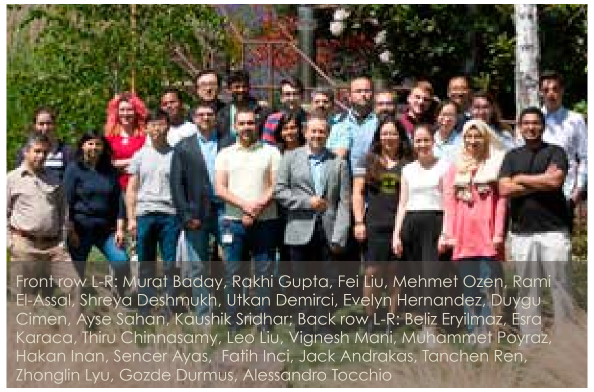
The Canary Center at Stanford is a world-class facility dedicated to early cancer detection research programs. The mission of the center is to foster research leading to the development of diagnostic tests and molecular imaging approaches to detect and localize aggressive cancers at early, curable stages. The center is the first in the world to integrate research on *in vivo* and *in vitro* diagnostics to deliver these tests, by housing state-of-the-art core facilities and collaborative research programs bridging molecular imaging, proteomics, chemistry, biology, engineering, and bioinformatics. These initiatives have extensive links to the Stanford Cancer Institute, forming a direct pipeline for the translation of early cancer detection research into clinical trials and practice.

ACHIEVEMENTS

- Our Preclinical Imaging Facility was established as a full Stanford University Service Center in 2016, providing equipment and services to internal and external users.

- As part of our mission to train the next generation of scientists, our summer internship program was formalized and expanded, and is now supported with a training award from the NIH/NCI.

- Seed funding was used to initiate new collaborations, resulting in several larger grants obtained for these innovative early cancer detection projects.



Front row L-R: Murat Baday, Rakhi Gupta, Fei Liu, Mehmet Ozen, Rami El-Assal, Shreya Deshmukh, Utkan Demirci, Evelyn Hernandez, Duygu Cimen, Ayse Sahan, Kaushik Sridhar; Back row L-R: Beliz Eryilmaz, Esra Karaca, Thiru Chinnasamy, Leo Liu, Vignesh Mani, Muhammet Poyraz, Hakan Inan, Sencer Ayas, Fatih Inci, Jack Andrakas, Tanchen Ren, Zhonglin Lyu, Gozde Durmus, Alessandro Tocchio

Demirci BAMM Lab

Utkan Demirci, PhD

One of the greatest achievements in medicine is the remarkable progress that has been made in understanding, diagnosing, monitoring, and treating disease conditions by creating innovative micro/nanoscale technologies. We have made seminal contributions and inventions for the development of microfluidic bio-imaging/sensing platforms for point-of-care diagnostics with broad medical applications. We have developed tools for detecting cells/cancer biomarkers and isolating exosomes from body fluids. We have created microfluidic tools to mimic the cancer microenvironment for investigating metastasis. We made breakthroughs in cell-sorting and single-cell imaging by magnetically levitating cells to isolate circulating tumor cells/clusters from blood with applications in precision-medicine; developed a microfluidic technology for sperm selection resulting in 5,000+ newborns globally and integrated it with lens-free, super-resolution imaging. We created successful start-ups bringing these technologies into the clinic.

ACHIEVEMENTS

• Best poster, Canary Center competition: "The Early Detection of Pancreatic Cancer Using Exosomes as Novel Biomarkers" and "Bioprinted Microfluidic 3-D Lung Cancer Microenvironments for Detection of Histone Modification and Cell Migration" (2017).

• The Academy for Radiology & Biomedical Imaging Research Distinguished Investigator Award (2017).

• Basic Scientist of the Year, Stanford University School of Medicine, Department of Radiology (2016).

• Elected to AIMBE College of Fellows (2017).

Clockwise: Joanna Sylman, Justin Carden, Hunter Boyce, Gautam Machiraju, Parag Mallick, Michelle Atallah, Michelle Hori

Multi-scale Diagnostics Lab

Parag Mallick, PhD

The Mallick lab focuses on translating multi-omic discovery into precision diagnostics. In particular, we use tightly integrated computational and experimental approaches to discover the processes underlying how cells behave (or misbehave) and accordingly how cancers develop and grow. We hope that by exploring these processes, and by formalizing our knowledge in predictive mathematical models, we will be able to better identify biomarkers that can be used to detect cancers earlier and describe how they are likely to behave (e.g., aggressive vs. indolent, drug sensitive vs. responsive). We are specifically working in three focus areas: Cancer Systems Biology, Multi-scale Biomarker Biology, and Technology Development.

ACHIEVEMENTS

• Development of the DISK/Spellbook ecosystem—a set of open-source tools to accelerate the extraction of knowledge from complex multi-omics data.

• Machine reading tools for extracting biomarkers from scientific articles.

• Use of multi-dimensional pathology data to demonstrate the role of micro-environment in driving tumor heterogeneity and drug resistance.

Early Lung Cancer Detection Lab

Viswam Nair, MD, MS

Dr. Nair's group focuses on (1) integrating clinical imaging and non-invasive biomarkers to develop new, improved diagnostic models for personalizing medicine, (2) understanding the current limitations of "omics" and biomarker studies in clinical practice, and (3) identifying and reducing health disparities for patients at risk for lung cancer. Dr. Nair is a clinical researcher who currently holds a faculty appointment in the Division of Pulmonary and Critical Care Division (Medicine) and the Canary Center at Stanford for Cancer Early Detection (Radiology), where he leads clinical programs in lung nodule evaluation and lung cancer screening.

ACHIEVEMENTS

• Our group has successfully established the Northern California Novel Cell and Radiology (NO CANCER) Biomarkers Initiative, an ongoing investigation of nearly 500 patients who undergo PET-CT imaging and molecular biomarker analysis in all stages of lung cancer.

• We partner closely with basic investigators to define the utility of innovative assays designed to detect cancer in the blood.

• We are using unique epidemiologic, imaging, and molecular data to define how best to approach evaluating the Solitary Pulmonary Nodule (SPN), a radiologic finding that physicians can expect to encounter in 1.5 million adults and where cancer must be effectively ruled out.

L-R: Abel Bermudez, Alisha Birk, Sharon Pitteri, Catherine Going, Christine Yeh, Sarah Totten, Jessica Zuniga

Cancer Molecular Diagnostics Lab

Sharon Pitteri, PhD

The Pitteri Laboratory is dedicated to early detection of aggressive cancer through the development of new *in vitro* diagnostic strategies. We are investigating molecules in blood, tissue, and other bodily fluids that can be used as disease biomarkers. To develop molecular signatures for disease diagnosis, we are particularly interested in exploiting aberrant glycosylation—a well-established but poorly understood feature—in tumorigenesis. Our recent work has focused primarily on breast and prostate cancers, where we have focused on distinguishing benign from malignant lesions and distinguishing indolent from aggressive disease, respectively. We have active collaborations with clinicians and other scientists to apply our technologies to study clinical samples, cell lines, and mouse models.

ACHIEVEMENTS

• We are collecting interstitial fluid in the Breast Imaging Clinic to measure proteins in the tumor microenvironment that are capable of distinguishing benign from malignant lesions.

• We have developed methods to systematically identify, localize, characterize, and quantify glycosylated proteins in biological samples.

• We are understanding differential protein glycosylation in prostate tumor samples from men with aggressive vs. indolent cancer, and in blood samples from men with benign vs. malignant disease.

L-R: Mark Buckup, Meghan Rice, Austin Su, Merve Aslan, En-Chi Hsu, Toni Benevento, Tanya Stoyanova, Ali Ghoochani

Molecular Targets for Diagnosis and Treatment Discovery Lab

Tanya Stoyanova, PhD

Dr. Stoyanova's research focuses on understanding fundamental molecular mechanisms underlying cancer development. Currently, her group studies signaling cascades initiated by cell surface receptors, which are involved in the early event of prostate cancer initiation and regulation of the transition from indolent to aggressive disease. The Stoyanova lab is also interested in developing new clinically relevant animal models to study genetic events and molecular mechanisms underlying cancer development.

The goal of Dr. Stoyanova's laboratory is to improve the stratification of indolent from aggressive prostate cancer and aid the development of better therapeutic strategies for the advanced disease.

Additionally, the lab is interested in understanding molecular mechanisms that govern the self-renewal activity of adult stem cells and cancer stem cells.

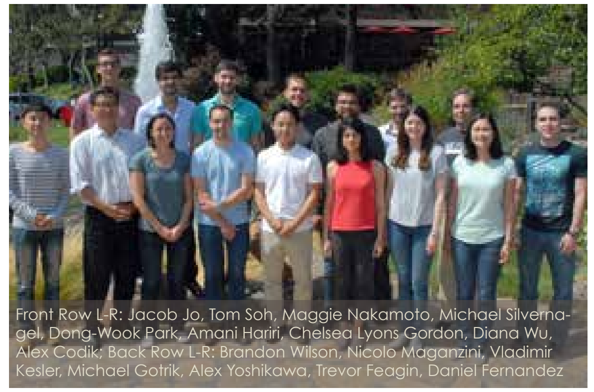
ACHIEVEMENTS

• Defining molecular drivers of aggressive prostate cancer.

• Developing novel tissue and blood based biomarkers for prostate cancer.

• Evaluating new therapies for advanced prostate cancer.

• Developing new clinically relevant models to study cancer.



Front Row L-R: Jacob Jo, Tom Soh, Maggie Nakamoto, Michael Silvernagel, Dong-Wook Park, Amani Hariri, Chelsea Lyons Gordon, Diana Wu, Alex Codik; Back Row L-R: Brandon Wilson, Nicolo Maganzini, Vladimir Kesler, Michael Gotrik, Alex Yoshikawa, Trevor Feagin, Daniel Fernandez

Soh Lab

H. Tom Soh, PhD

In order to achieve early and accurate detection of diseases, antibodies have been extensively used to specifically bind to disease biomarkers. Unfortunately, there are many types of important disease biomarkers, such as metabolites and carbohydrates, which antibodies cannot recognize. This has been a major problem for advancing molecular diagnostics in the clinic. In order to address this problem, our lab develops synthetic antibodies (called "aptamers") that can outperform natural antibodies. In order to achieve this, we use the principles of evolution (mutation, selection, and amplification) to create novel molecules that do not exist in nature. We then use these aptamers to develop advanced biosensors that can achieve extremely sensitive detection of multiple biomarkers in clinical samples. For example, our laboratory pioneered the development of "real-time biosensors" that can continuously measure target molecules directly in living animals. We hope to expand these measurement techniques and bring them into the clinic to accurately detect diseases at their earliest stages.

ACHIEVEMENTS

• Developed high-throughput technology to generate synthetic antibodies ("aptamers") with higher performance than monoclonal antibodies.

• Developed non-natural aptamers that can target biomarkers that antibodies cannot recognize.

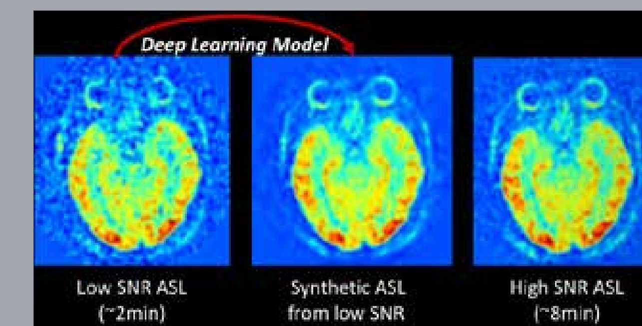
• Demonstrated the first real-time closed-loop control of drug level in live animals.

Feature

Medical ImageNet

Next-Generation Research PACS for Diagnostic Image Analysis using Artificial Intelligence

A picture archiving and communication system (PACS) is invaluable for storing and displaying clinical imaging data. However, a clinical PACS is not well suited for research applications because frequent retrieval of large volumes of research study data can significantly impede the clinical PACS performance. To address these challenges, Stanford is creating a "research PACS" to facilitate the usage of clinical imaging data for research.



Use of deep learning to improve radiology image quality. In this example, an arterial spin label (ASL) MRI scan, which maps cerebral blood flow, can be acquired within 2 minutes, but this results in a low quality image (left). By training a deep neural network, it is possible to synthesize an ASL scan with markedly reduced image noise and increased image quality (middle). The quality is similar to that of a high quality ASL study that required 8 minutes to obtain (right). (Images courtesy of Dr. Greg Zaharchuk, Center for Advanced Functional Neuroimaging [CAFN], Stanford).

Advancements in computer vision have created a particularly compelling need for massive clinical imaging data sets to be mined and explored. In the past, the creation of decision support systems to assist medical imaging professionals required "feature engineering"—the painstaking manual design of algorithms to analyze images. Recent progress in artificial intelligence has replaced feature engineering with a more efficient and scalable neural network process, based on machine learning from large sets of annotated training data.

ImageNet, a database of over 14 million human-annotated non-medical images created by Dr. Fei Fei Li, a Stanford professor of computer science, has been instrumental in the success of computer vision systems outside of medicine. When these same methods are applied to medical imaging data, "deep" neural network-based techniques—with tens of millions of parameters—can perform some medical image interpretation tasks at the level of expert physicians and provide rich real-time decision support.

Inspired by *ImageNet*, Stanford Radiology's research PACS is called *Medical ImageNet*, and is a cloud-based, petabyte-scale (that is a million gigabytes), fully anonymized, searchable, and shareable repository of diagnostic imaging studies for the development of intelligent image analysis systems. Natural language processing methods will be used to label this repository of 5 million imaging studies for machine learning applications. The imaging data will become part of the School of Medicine's enterprise data warehouse, where it will be linked to information from the electronic patient record, including genomic data. Tools created from this platform will significantly improve radiologists' ability to detect and respond to emergency events, improve image quality control, and automate report drafting. These machine learning tools also have the potential to reduce diagnostic medical errors, which can cause significant patient harm and play a role in up to 10% of patient deaths. Medical diagnosis is a highly perceptual task that will always require human interaction—with those who adapt to using these advanced diagnostic tools outperforming those who do not.

Stanford's *Medical ImageNet* is currently being used to develop systems in computer-aided detection and classification, image-derived prognosis, and image-gene relationships. The long-term vision is to continue the development of this facility within a center of excellence for artificial intelligence in medical imaging, which develops, evaluates, and disseminates artificial intelligence systems that reduce diagnostic medical errors. This effort will draw upon collaborative informatics research with faculty in the Department of Biomedical Data Science, and the Division of Biomedical Informatics Research in the Department of Medicine, and leverage expertise from the Departments of Computer Science, Electrical Engineering, Psychology, and Bioengineering. Furthermore, because of Stanford's presence in Silicon Valley, it is easily accessible to potential commercial partners, both startups and established companies.

The vision for Stanford's *Medical ImageNet* and the development of the research PACS has been spearheaded by Dr. Curtis Langlotz (Professor and Associate Chair for Information Systems, Radiology).

DIVISION LEADERSHIP

Sandy Napel, PhD
Sylvia Plevritis, PhD

SELECTED FUNDING

Qualification and Deployment of Imaging Biomarkers of Cancer Treatment Response. NIH 5 U01 CA190214 03 (Rubin)

Computing, Optimizing, and Evaluating Quantitative Cancer Imaging Biomarkers. NIH/NCI 5 U01 CA187947 03 (Napel/Rubin)

Modeling the Role of Lymph Node Metastases in Tumor-Mediated Immunosuppression. NIH/NCI 5 U54 CA209971 02 (Plevritis/Nolan)

SELECTED PUBLICATIONS

Liu TT, Achrol AS, Mitchell LA, Rodriguez SA, Feroze A, Iv M, Kim C, Chaudhary N, Gevaert O, Stuart JM, Harsh GR, Chang SD, Rubin DL,. Magnetic Resonance Perfusion Image Features Uncover An Angiogenic Subgroup of Glioblastoma Patients with Poor Survival and Better Response to Antiangiogenic Treatment. Neuro-Oncology, 2016 Dec 22 (Epub ahead of print).

Gevaert O, Echegaray S, Khuong A, Hoang CD, Shrager JB, Jensen KC, Berry GJ, Guo HH, Lau C, Plevritis SK, Rubin DL, Napel S, Leung AN. Predictive Radiogenomics Modeling of EGFR Mutation Status in Lung Cancer. Scientific Reports, 2017 Jan 31; 7:41674. PMCID: PMC5282551.

Anchang B, Hart T, Bendall SC, Qiu P, Bjornson Z, Linderman M, Nolan GP, Plevritis SK. Visualization and Cellular Hierarchy Inference of Single-Cell Data Using SPADE. Nature Protocols, 2016 Jul; 11(7):1264–1279.

Hassanpour S, Langlotz CP, Amrhein TJ, Befera NT, Lungren MP. Performance of a Machine Learning Classifier of Knee MRI Reports in Two Large Academic Radiology Practices: A Tool to Estimate Diagnostic Yield. AJR American Journal of Roentgenology, 2017 Apr; 208(4):750–753.

The image shows a "saliency map", highlighting the areas of the image used by a machine learning algorithm to formulate a recommendation. Algorithms like this will help the human and machine work cooperatively, by explaining the machine's rationale.

Integrative Biomedical Imaging Informatics at Stanford (IBIIS)

The Integrative Biomedical Imaging Informatics at Stanford (IBIIS) Division of the Department of Radiology focuses on pioneering, translating, and disseminating methods using imaging information sciences to better understand health and disease, and to improve clinical care. Research activities include development and investigation of: (1) large-scale databases integrating imaging, cellular and molecular analyses, and all other aspects of the medical record, (2) image analysis methods to identify critical findings from imaging examinations in near real-time, (3) natural language processing to extract discrete data from human interpretations of images, (4) conventional and deep learning algorithms for analysis of massive data sets containing images and other health data, (5) correlation of imaging appearance with molecular profiles of tissue, (6) development of novel imaging-based biomarkers of disease and response to therapy, (7) data-driven models of cancer progression, and (8) development and evaluation of cancer screening programs.

ACHIEVEMENTS

- Created new quantitative imaging databases in lung, liver, and brain cancer.
- Developed a first-ever approach to leverage single cell data for optimizing drug combinations.
- Discovered tumor-stromal mechanisms associated with FDG uptake as seen on PET imaging through genomic and proteomic characterization.
- Discovered novel quantitative imaging features in MRI images of brain cancer that identify subtypes of this disease that are sensitive to particular drug treatments.
- Developed a deep learning model to assess skeletal maturity on pediatric hand radiographs that performs at the level of human experts.

Front row L-R: Hersh Sagreiya, Safwan Halabi, Curtis Langlotz, Maxwell; Cheong; Middle row L-R: Lewis Hahn, Kristen Yeom, Darvin Yi, Roger Goldman; Back Row L-R: Chris Beaulieu, David Larson

Langlotz Lab

Curtis Langlotz, MD, PhD

Our lab investigates the use of deep neural networks and other machine learning methods to help radiologists detect disease and eliminate diagnostic errors. We use artificial intelligence techniques to evaluate image quality, identify critical findings, and classify imaging abnormalities. When our results show potential, we evaluate their clinical utility in the reading room and disseminate them as open source or commercial software.

To support our efforts, we are developing a massive research database containing 5 million images from our hospital picture archiving and communication system (PACS). The laboratory develops natural language processing methods that extract information from narrative radiology reports to label the imaging studies automatically. This labeled image dataset serves as large annotated image training sets for supervised machine learning experiments. We call this resource, *Medical ImageNet*, after the *ImageNet* resource that catalyzed research progress in computer vision outside medicine.

ACHIEVEMENTS

- Created a machine learning algorithm that performs at the level of expert human radiologists in estimating the physiologic age of children.
- Developed a machine learning classifier of knee MRI reports and conducted a multi-institutional evaluation of its accuracy.
- Published a probabilistic model that calculates the differential diagnosis of bone tumors.
- Developed software tools that enable rapid image labeling.
- Implemented a software pipeline that enables bulk transmission and de-identification of clinical imaging data in the cloud.

Front row L-R: Dev Gude, Sebastian Echegaray, Sandy Napel, Sarah Mattonen, Sheryl John, Emel Alkim; Back row L-R: Akshay Jaggi, Shaimaa Bakr

Radiological Image and Information Processing

Sandy Napel, PhD

Our lab focuses on developing new techniques to determine diagnosis and to predict prognosis, response to treatment, and outcomes from images and other associated data. This involves the development of algorithms to make image features computer accessible (e.g., volumes, lengths, shapes, edge sharpness, curvatures, textures), the building of integrated databases combining features of multidimensional radiological images and other clinical data, including molecular assays of biopsies and/or resected tissue, and machine learning algorithms to make inferences from the integrated data. Ultimately, we aim to translate these developments into clinical applications, including content-based medical image retrieval and decision support systems for radiologists. We primarily work with cross-sectional images, including CT, MRI, and ultrasound, and specialize in cancer imaging, focusing mostly on lung, liver, and brain cancer.

ACHIEVEMENTS

- Participated in international networks for tool and algorithm sharing for cancer imaging.
- Developed a community-accessible and expandable resource for computation of image features from collections of 2D and 3D medical images.
- Completed several databases linking images to molecular properties of tumor tissue.
- Built several novel models linking image features to outcomes and molecular properties of lung, brain and liver tumors.
- Awarded several major grants for developing tools and databases for quantitative imaging.

L-R: Jane Wei, Irene Li, Weiruo Zhang, Cong Xu, Alice Yu, Loukia Karacosta, Gina Bouchard, Alborz Bejnood, Sylvia Plevritis, Zacharias Raptopoulos, Ramzi Totah, Iakovos Toumazis, Benedict Anchang, Melissa Ko, Janet Li; Not in picture: Theresa McCann, David Knowles, Archana Shenoy

Cancer Systems Biology Lab

Sylvia Plevritis, PhD

The Cancer Systems Biology Laboratory (CSBL) aims to unravel the molecular mechanisms underlying cancer progression to identify novel approaches to early detection and effective treatment of cancer. Our work involves the analysis of cancer as a complex system whose components can be reverse-engineered from multi-omics data. Our active research projects include: (1) reconstructing intra- and inter-cellular communication networks of cancer from genomic, proteomic and radiomic data, (2) optimizing combination drug therapy strategies, and (3) quantifying the impact of risk-based screening and molecularly targeted therapeutics on population cancer incidence and mortality rates. Ultimately, our goal is to develop a multiscale view of cancer progression for improving early detection and treatment strategies for the individual patient. CSBL brings together computer scientists, statisticians, engineers, biological experimentalists and clinical researchers for a multidisciplinary approach to tackle cancer.

ACHIEVEMENTS

- Discovering new insights in tumor metabolism on PET imaging through radiogenomic analysis.
- Identifying mechanisms of tumor immunosuppression by integrating imaging and genomics.
- Mapping the lung cancer states in clinical samples in terms of the epithelial-to-mesenchymal transition.
- Estimating breast cancer recurrence rates in the U.S. population.
- Simulation of CT-based lung cancer screening strategies on the U.S. population outcomes.
- Training the next generation of scientists in the Stanford Cancer Systems Biology Scholars (CSBS) Program.

Front row L-R: Sahana Srinivasan, Sheryl John, Emel Alkim, Myra Cheng, Angela Kim, Daniel Rubin, Akhil Arun, Leyton Ho, Hersh Sagreiya; Back row L-R: David Cohn, Alfiia Galmzianova, Sammy Zhang, Assaf Hoogi, Anum Sayed, Carson Lam, Darvin Yi, Selen Bozkurt, Blaine Rister

Quantitative Imaging Lab

Daniel Rubin, MD, MS

Our laboratory develops artificial intelligence methods and computational tools to realize precision health and to enable better care in disease. We translate our discoveries into practice through decision support applications to reduce variation in clinical care and to improve patient outcomes. Our work spans the spectrum from basic science discovery (discover image phenotypes to define subtypes of diseases and to understand their molecular characteristics) to clinical practice through translational research (decision support, disease profiling, treatment response assessment, and personalized treatment selection). Our vision is that computational approaches to mining large collections of integrated molecular, clinical, and image data will drive scientific discovery, help to predict/detect disease, and guide clinical practice. Our ultimate goal is to bring cutting-edge radiological data and knowledge into disease prediction and to promote precision care of patients.

ACHIEVEMENTS

- Discovered novel quantitative imaging features in MRI images of brain cancer that identify subtypes of this disease that are sensitive to particular drug treatments.
- Expanded the ePAD semantic image annotation technology (http://epad.stanford.edu) by integrating it with the Quantitative Imaging Feature Pipeline (http://qifp.stanford.edu) platform—both developed by our group—to enable large scale science with images and machine learning to recognize disease subtypes and predict clinical outcomes.
- Developed novel natural language processing methods to automatically code and summarize narrative radiology reports, enabling pursuit of health services research questions.

DIVISION LEADERSHIP

Sanjiv Sam Gambhir, MD, PhD
Gunilla Jacobson, PhD

SELECTED FUNDING

Cancer-Translational Nanotechnology Training (Cancer-TNT) Program. NIH/NCI 5 T32 CA196585 02 (Rao/Felsher)

Stanford Molecular Imaging Scholars (SMIS) Program. NIH/NCI 2 T32 CA118681-12A1 (Levin)

Center for Cancer Nanotechnology Excellence for Translational Diagnostics (CCNE-TD). NIH/NCI 5 U54 CA199075 03 (Gambhir/Wang)

Multiple funding sources by individual faculty grants and industry collaborations

SELECTED PUBLICATIONS

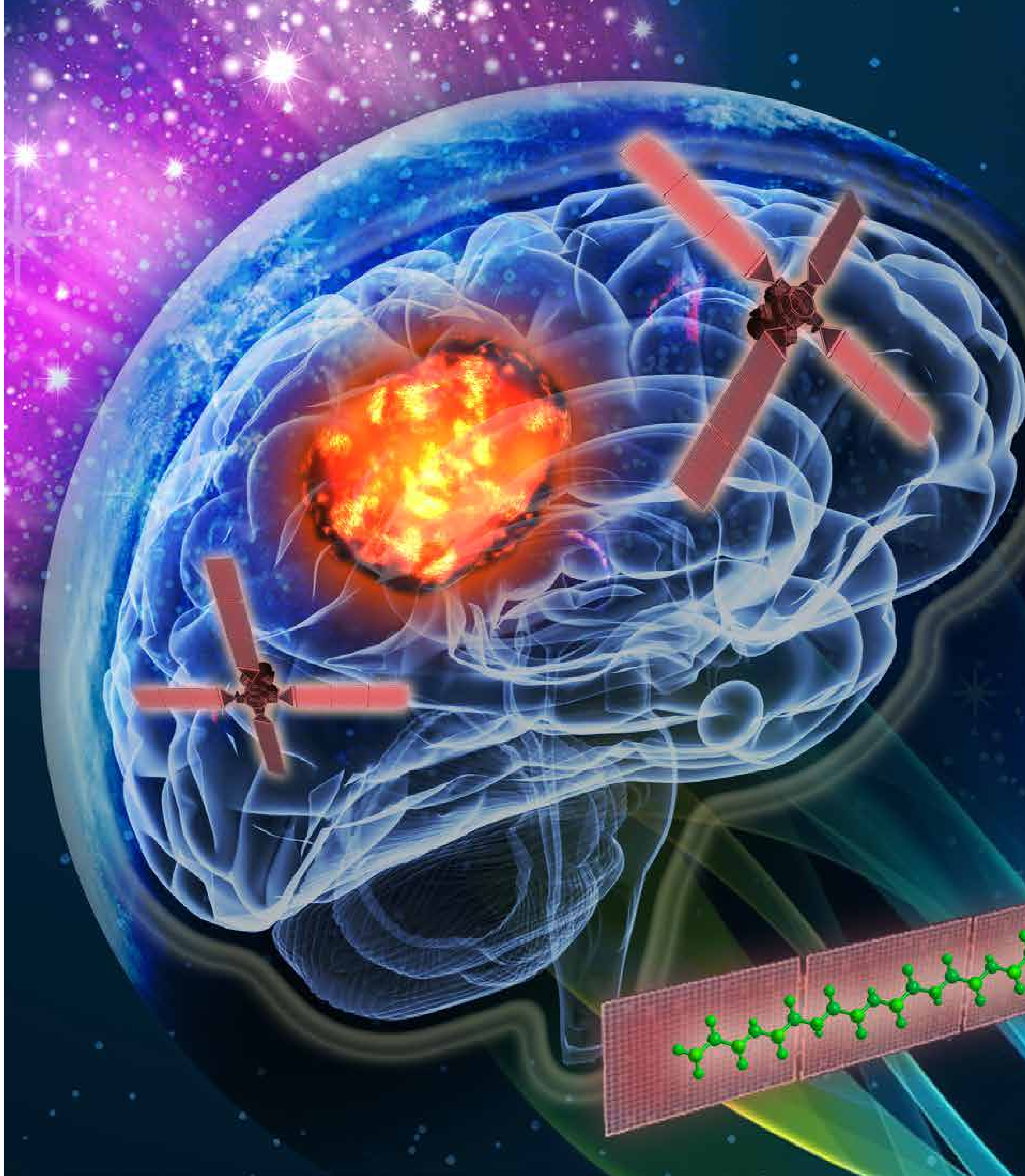
Keu KV, Witney TH, Yaghoubi S, Rosenberg J, Kurien A, Magnusson R, Williams J, Habte F, Wagner JR, Forman S, Brown C, Allen-Auerbach M, Czernin J, Tang W, Jensen MC, Badie B, Gambhir SS. Reporter Gene Imaging of Targeted T Cell Immunotherapy in Recurrent Glioma. Science Translational Medicine, 2017 Jan 18: 9(373). PMCID: PMC5260938.

Willmann JK, Bonomo L, Testa AC, Rinaldi P, Rindi G, Valluru KS, Petrone G, Martini, Lutz AM, Gambhir SS. Ultrasound Molecular Imaging with BR55 in Patients with Breast and Ovarian Lesions: First-In-Human Results. Journal of Clinical Oncology, 2017 Jul 1; 35(19):2133–2140. PMCID: PMC5493049.

Antaris AL, Chen H, Cheng K, Sun Y, Hong G, Qu C, Diao S, Deng Z, Hu X, Zhang B, Zhang X, Yaghi OK, Alamparambil ZR, Hong X, Chneg Z, Dai H. A Small-Molecule Dye for NIR-II Imaging. Nature Materials, 2016 Feb; 15(2):235–242.

Zanganeh S, Hutter G, Spitler R, Lenkov O, Mahmoudi M, Shaw A, Pajarinen JS, Nejadnik H, Goodman S, Moseley M, Coussens LM, Daldrup-Link HE. Iron Oxide Nanoparticles Inhibit Tumour Growth by Inducing Pro-Inflammatory Macrophage Polarization in Tumour Tissues. Nature Nanotechnology, 2016 Nov; 11(11):986–994. PMCID: PMC5198777.

Liby O, SoRelle ED, Sen D, de la Zerda A. Contrast-Enhanced Optical Coherence Tomography with Picomolar Sensitivity for Functional In Vivo Imaging. Scientific Reports, 2016 Mar 18; 6:23337. PMCID: PMC4796912.



A small organic molecule dye, CH1055, for the second near-infrared window (NIR-II, 1000–1700 nm) fluorescent imaging of tumor and image-guided glioblastoma surgery [Nature Materials, 2016;15(2):235–42].

Molecular Imaging Program at Stanford (MIPS)

Our continuing vision for the Molecular Imaging Program at Stanford (MIPS) has been to bring molecular imaging technologies to basic science cancer researchers. We create an environment in which non-invasive imaging technologies that permit longitudinal studies of tumor initiation, progression, metastasis, and response to therapy is adopted by basic scientists studying cancer. Within the MIPS program, we continue to develop animal models of cancer in which molecular imaging adds new dimensions to experimental design and allows investigators to acquire time-dependent data that could not be obtained in any other way. The MIPS program is supported by numerous funding sources, including the National Institutes of Health, multiple foundations, and strong industry partnerships. Since the inception of MIPS (2003), we have followed a clearly defined roadmap toward translating our work into clinical use to benefit patients.

ACHIEVEMENTS

- Eight new faculty joined MIPS, establishing a total group of 28 faculty spanning 11 different departments on campus.
- Dr. Heike Daldrup-Link joined the MIPS leadership team as Director of Pediatric Molecular Imaging.
- A new Molecular Imaging Young Investigator (MIYI) prize was established, and the first two recipients were Dr. Katheryne Wilson, and Dr. Jinghang Xie.

L-R: Jeff Wang, Muna Aryal's spouse, Muna Aryal, Molly Lucas, Raag Airan, Byun (Jason) Yoon, Qian Zhong

Noninvasive Neurointerventions Lab

Raag Airan, MD, PhD

The Noninvasive Neurointerventions (n_i^2) Lab is focused on developing novel molecular interventions for interrogating and treating the nervous system, primarily through focused ultrasound mediated targeted drug delivery. We are adapting the use of "phase-change" nanotechnology to focally deliver neuromodulators to the brain to enable spatiotemporally-precise and receptor-specific noninvasive neuromodulation. In addition, we are implementing clinical protocols for targeted, safe, and reversible blood-brain barrier opening to increase chemotherapeutic delivery to the brain. Finally, we are exploring methods to use these technologies to focally modulate cerebral perfusion and the neural immunological response.

Working in a multidisciplinary space that involves radiology, neurosurgery, neurology, and psychiatry, the n_i^2 lab is driven to combine advances in drug delivery nanotechnology and focused ultrasound to enable noninvasive, spatially, and temporally precise drug delivery to the brain.

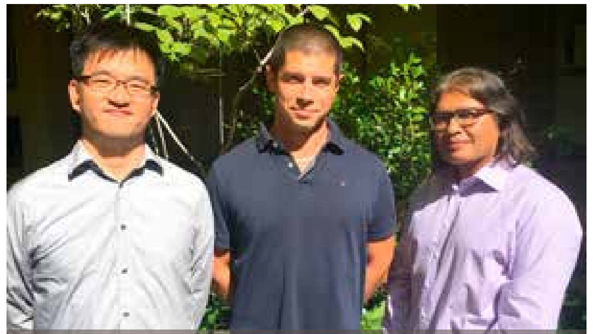
ACHIEVEMENTS

- Established neuro-electrophysiology and neuro-behavioral assays as new core techniques for the department.

- Developed a variety of drug-encapsulated ultra-sound-sensitive nanoparticles that may be used to focally modulate varied brain receptor systems.

- Successfully implemented these tools to focally and selectively modulate evoked brain electrical activity.

- Developed and validated aseptic methods to produce these nanoparticles at scales relevant for eventual clinical translation.



L-R: Daehyun Yoon, Peter Cipriano, Sandip Biswal

Molecular Imaging of Nociception and Inflammation Lab

Sandip Biswal, MD

Chronic pain sufferers are, unfortunately, limited by poor diagnostic tests and therapies. Our lab is interested in the "imaging of pain" by using multimodality molecular imaging techniques to study molecular and cellular changes specific to nociception and painful inflammation as a means of improving objective, image-guided diagnosis, and treatment of chronic pain disorders. We develop new molecular contrast agents for use in positron emission tomography (PET) and magnetic resonance imaging (MRI) and are currently conducting two clinical trials using the relatively new hybrid imaging technique of PET-MR. The overarching goal of our efforts is to develop an imaging approach that will pinpoint the exact cause of one's pain, improve outcomes of pain sufferers, and to help develop new treatments for chronic pain.

ACHIEVEMENTS

- Clinical trials to identify chronic pain generators:
    - [^{18}F]FTC-146 PET-MR in healthy volunteers and in patients with CRPS and sciatica.
    - Use of [^{18}F]-FDG PET-MR to diagnose increased nociceptive activity and neural inflammation in patients with chronic pain.
- Publications:
    - First-in-human application of [^{18}F]FTC-146, the sigma-1 receptor radioligand.
    - Biodistribution and dosimetry of FTC-146 in healthy subjects.
    - Initial experience with clinical-grade [^{18}F]FTC-146: Radiosynthesis and first-in-human PET-MRI evaluation.

Front row L-R: Hui Wang, Yan Cheng, Si Chen, Yuebing Wang; Back row L-R: Kun Qian, Hao Chen, Zhen Cheng, Ning Zhao, Sorel Kurbegovic, Bingbing Ding

Cancer Molecular Imaging Chemistry Lab

Zhen Cheng, PhD

The overall objective of this laboratory is to develop novel molecular imaging techniques and theranostic agents for early diagnosis and treatment of severe diseases, including cancer, neurological, and cardiovascular diseases. We have aimed to identify novel cancer biomarkers with significant clinical relevance, explore new chemistry and platforms for imaging probe preparation, and develop new imaging strategies for clinical translation. To accomplish these goals, a multidisciplinary team composed of members with expertise in organic chemistry, radiochemistry, biochemistry, bionanotechnology, molecular and cell biology, radiological science, medicine, and molecular imaging has been built to implement several research projects related to molecular imaging.

ACHIEVEMENTS

- Developed a new class of small molecule-based dyes for *in vivo* near-infrared window II imaging of a variety of diseases models.

- Developed a variety of new nanoplatforms such as melanin nanoparticles, gold-tripod nanoparticles, Au-Iron oxide heterostructures, and Perylene-diimide-based nanoparticles for cancer multimodality imaging and theranostics.

- Developed several clinical translatable PET probes for cancer, cardiac, and neurological disease imaging.

- Established Cerenkov luminescence imaging (CLI) as a new approach for bioimaging and further developed new molecular probes for CLI.

Front row L-R: Emily Carmen Azevedo, Jessa Castillo, Zhang Miao, Mia Tockey, Frederick Chin, Bin Shen, Soujanya Gade; Back row L-R: Jessica Klockow, Kenneth Hettie, Muru Subbarayan, George Montoya, Samantha Levine, Berend Van der Wildt, Eric Jeong, Walid Alsharif, Jun Hyung Park

TRACER for Molecular Imaging Lab

Frederick Chin, PhD

The Translational Radiopharmaceutical Sciences and Chemical Engineering Research (TRACER) for Molecular Imaging Laboratory specializes in synthetic chemistry and focuses on advancing radiopharmaceutical sciences for the expanding field of molecular imaging. We design and synthesize novel chemical strategies that bind to various molecular targets related to specific neuropsychiatric disorders, pain, and cancer biology. In addition, new radiolabeling techniques and methodologies are created in our lab for emerging radiopharmaceutical development as well as for the general radiochemistry community. These radiochemistry approaches are coupled with innovative chemical engineering and *in vivo* models to further investigate new molecular imaging strategies. Successful imaging agents are also extended towards human clinical applications including disease detection and drug therapy.

ACHIEVEMENTS

- Cross-species multi-modal neuroimaging to investigate GABA physiology in Fragile X syndrome. (Collaboration with Lawrence Fung, Scott Hall, Jennifer McNab, and Dan Spielman).

- Radiosynthesis and first-in-human PET-MRI evaluation with clinical-grade [^{18}F]FTC-146. (Collaboration with Sandip Biswal and Chris McCurdy).

- PET-MR imaging of peripheral neural sigma-1 receptor expression in a neuropathic pain model. (In additional collaborations with Sandip Biswal, Chris McCurdy, Joe DeMartini, and Mathieu Spriet; clinical studies with [^{18}F]FTC-146 are ongoing in both human and equine pain subjects).

- Developed novel clinically translatable imaging probes (e.g., PET, NIR-I/II) to study cancer biology, specifically the tumor microenvironment.

Front row L-R: Hossein Nejadnik, Eileen Misquez, Anne Muehe, Heike Daldrup-Link, Maryam Aghighi, Praveen Gulaka, Laura Pisani
Back row L-R: Ramitha Nyalakonda, Zixin Chen, Anuj Pareek, Jessica Klockow, Suchismita Mohanty, Kai Li, Ashok Theruvath, Olga Lenkow

Pediatric Molecular Imaging Lab

Heike Daldrup-Link, MD

Our research team aims to provide pediatric patients with more efficient and accurate disease diagnoses than currently available. In the past, pediatric radiology essentially depicted human anatomy. Modern medicine needs more advanced information. We combine innovations in nanoparticle development and medical imaging towards the development of novel imaging techniques, which can detect specific cells in the body and monitor their function at a molecular level. We developed novel imaging techniques for radiation-free cancer staging, imaging techniques for tracking of stem cell transplants in leukemia patients and "theranostic" (combined diagnostic and therapeutic) nanoparticles for image guided cancer therapy. A number of these molecular imaging technologies have been successfully translated from our basic science lab to clinical imaging applications, thereby creating direct value for our pediatric patients.

ACHIEVEMENTS

- Seven trainees honored for innovative imaging research (Kai Li (twice), Preeti Sugerkar, Anat Ilivitzki, Maryam Aghighi, Christopher Klenk, Hossein Nejadnik).

- Patent US 9579349 filed for *in vivo* iron labeling of stem cells and tracking these stem cells after transplantation; currently evaluating in a "first-in-patient" clinical trial.

- Patent WO 2015014756 A1 filed for a tumor enzyme-activatable theranostic drug that provides image guided cancer therapy without side effects; now being evaluated by the NIH Cancer Nanocharacterization Lab, a first step to clinical translation.

- Discovery of unexpected intrinsic therapeutic effect of iron oxide nanoparticles on the immune cell composition in cancers: nanoparticles can prevent or inhibit the growth of early cancers (Nature Nanotechnology 2017).

1st row L-R: Seung-Min Park, Sanjiv Sam Gambhir, Prachi Singh, Karen Eliahu, Jennifer Cotton, Lingbo Zhang, Sharon Hori, Sindhuja Ramakrishnan, Hui-Yen Chuang, Israt Alam, Aimen Zlitni; 2nd row L-R: Lingyun Xu, Ophir Vermesh, Aaron Mayer, Arutselvan Natarajan, Ryan Davis, Anjay Saklecha, Elise Robinson, Cayo Gonzalez, Edwin Chang, Amin Aalipour, Kezheng Wang; 3rd row L-R: Diego Escobedo, Surya Murty, Aloma D'Souza, Corinne Beinat, Tom Haywood, Travis Shaffer, Mirwais Wardak, Stefan Harmsen, Stephan Rogalla, Idan Steinberg, Jonathan Song, Luis Dan Curet, Jung Ho Yu, Chirag Patel; 4th row L-R: Mohammad Namavari, Gayatri Gowrishankar, David Anders, Takeshi Fuchigami, David Huland

Multimodality Molecular Imaging Lab

Sanjiv Sam Gambhir, MD, PhD

The Multimodality Molecular Imaging Laboratory is developing imaging assays to monitor fundamental cellular/molecular events in living subjects, including patients. Technologies such as positron emission tomography (PET), optical (fluorescence, bioluminescence, Raman), ultrasound, and photoacoustic imaging are all under active investigation.

Imaging agents for multiple modalities including small molecules, engineered proteins, and nanoparticles are under development and being clinically translated. Our goals are to detect cancer early and to better manage cancer through the use of both *in vitro* diagnostics and molecular imaging. Strategies are being tested in small animal models and are also being clinically translated.

ACHIEVEMENTS

- First-in-man studies of a new $\alpha v\beta 6$ PET tracer based on the knottin scaffold. This tracer should help identify several cancer types including pancreatic cancer for which there are no good imaging agents to date.

- Development of several new PET tracers for imaging the immune system including, checkpoint inhibitor imaging and the imaging of cell surface receptors (e.g., OX40) on activated T cells.

- Development of new strategies for treating glioblastoma with tumor treating fields and herbal agents.

- Development of new Raman and photoacoustic molecular imaging strategies for improved cancer detection.

- 10 patents filed on multimodality molecular imaging strategies.

L-R: Emily Johnson, Michelle James, Aisling Chaney, Niki Konstantinides; Not in picture: Marc Stevens, Haley Cropper

Neuroimmune Imaging Research and Discovery Lab

Michelle James, PhD

Our lab is improving the diagnosis and treatment of brain diseases by developing translational molecular imaging agents for visualizing neuroimmune interactions underlying conditions such as Alzheimer's disease, multiple sclerosis, and stroke.

We are researching how the brain, its resident immune cells, and the peripheral immune system communicate at very early to late stages of disease. Our approach involves the discovery and characterization of clinically relevant immune cell biomarkers, followed by the design of imaging agents specifically targeting these biomarkers, and finally, the translation of promising probes to the clinic, enabling the precision targeting of immunomodulatory therapeutics and real-time monitoring of treatment response in patients. We are passionate about our work, and excited about the impact these approaches will have in the lives of those suffering from debilitating brain diseases.

ACHIEVEMENTS

- Radioactive Drug Research Committee (RDRC) approval of [^{11}C]DPA-713, PET radiotracer for imaging the translocator protein 18 kDa (TSPO; a marker of glial activation/neuroinflammation) in patients at Stanford with Alzheimer's disease, stroke, or chronic fatigue syndrome.

- Successfully monitored beneficial response to a novel disease-modifying treatment for Alzheimer's disease using TSPO-PET imaging.

- Developed a new PET tracer for maladaptive myeloid cell-driven immune responses (PCT/US16/61577).

- First demonstration of imaging B cells in a multiple sclerosis mouse model.

L-R: Marina Karmanova, Jason Paik, Anna Marie Ajero, Shivaani Kummar, Stephanie Ezrati, JeeMin Lee, Feriel Buchholz, and Gabriel Schwartz

Phase I Clinical Research Program

Shivaani Kummar, MD

The Phase I Clinical Research Program specializes in the rapid completion of science driven trials tailored to make early, informed decisions about novel agents for further clinical investigation. Dr. Shivaani Kummar, MD, Director of the Program, and other co-investigators focus on designing and conducting pharmacokinetic and pharmacodynamic driven first-in-human trials, and integrating genomics and laboratory correlates into early phase trials.

ACHIEVEMENTS

- There are a number of early phase trials currently open for patients with advanced solid tumors, including novel immunotherapies and agents targeting genetic aberrations in cancer.

- The Phase I Clinical Research Program is a member of the California Cancer Consortium (along with UCSF, City of Hope, and UC Davis Cancer Centers), and part of the National Cancer Institute's Experimental Therapeutics Clinical Trials Network (ETCTN).

- The Phase I Clinical Research Program has collaborative efforts with a number of laboratories on campus to translate the discoveries into the clinic.

Front row L-R: Gregory Xie, Brian Lee, Don Vernokl, Craig Levin, Jim Best-Devereux, Garry Chinn, Katherine Kowalski, Qian Dong, Jonah Kohen. Back row L-R: Narain Vijayashanker, Evan Lee, Rachel Jorgensen, Derek Innes, Chen-Ming Chang, Joshua Spreng, Keumsil Lee, Alex Mihlin, Ilaria Sacco, Li Tao, Joshua Cates, David Hsu, David Freese

Molecular Imaging Instrumentation Lab

Craig Levin, PhD

The goal of the lab is to create novel instrumentation and software algorithms for *in vivo* imaging of molecular signatures of disease in living subjects. These new cameras efficiently image emissions from molecular contrast agents to probe disease biology in tissues residing deep within the body using measurements made from outside the body. The technology goals are to advance the sensitivity and spatial, spectral, and/or temporal resolutions, to create new camera geometries for special biomedical applications, to understand the entire imaging process comprising the subject tissues, radiation transport, and imaging system, and to provide the best available image quality and quantitative accuracy. The ultimate goal is to introduce these new imaging tools into studies of molecular mechanism and treatments of disease in living subjects.

ACHIEVEMENTS

• Awarded a Coulter Institute translational grant to design and develop a high performance and cost-effective solution for PET-MRI.

• Developed a practical photon detector technology that achieves <130 picoseconds coincidence time resolution to advance time-of-flight PET.

• Developed image reconstruction methods to enable ultra-high resolution images with a prototype of the world's first 1 mm resolution clinical PET system.

L-R: Maxim Moroz, Andreas Loening; Not pictured: Paul Stoddard

Body MR Translational Research Lab

Andreas Loening, MD, PhD

The lab focuses on research directed toward expanding the capability of MR and PET-MR as it relates to applications in body imaging. Clinical research aims include the application of new or improved MR sequences and reconstruction mechanisms to increase the speed, robustness, and diagnostic capability of body MR protocols, and combining PET molecular imaging agents with MRI to improve the diagnostic power of clinical imaging. Translational research aims include exploring new MRI contrast mechanisms and contrast agents, such as for the stratification of cancer within the prostate and the identification of metastatic disease involvement of lymph nodes.

ACHIEVEMENTS

• Improved accuracy of multi-parametric prostate MRI by incorporating small-field of view 3D T2-weighted imaging techniques.

• Implementation of variable refocusing flip angles and outer volume suppression techniques into single shot fast spin echo imaging to increase speed, imaging quality, and robustness of body MRI protocols.

• Clinical validation of complementary poisson-disc sampling with compressed sense reconstruction to add robustness to dynamic contrast enhanced abdominal MRI examinations.

• Creation of high-throughput and clinically relevant contrast agent screening mechanisms using a human derived prostate tissue slice cancer model.

L-R: Mallesh Pandrala, Sanjay Malhotra, Vineet Kumar, Saurin Holdheim, Angel Resendez, Dhanir Tailor, Alexander Honkala

Small Molecule Design Lab

Sanjay Malhotra, PhD, FRSC

Our laboratory focuses on the design and discovery of synthetic and natural product-inspired small molecules, which can be used as probes to understand biological phenomena, including protein-protein interactions and modulation of signal transduction pathways. We employ the tools of synthetic and medicinal chemistry, molecular modeling, and chemical biology for translational research in drug discovery, development, imaging and radiation. Our current projects include design of new scaffolds/molecules as chemical tools to study various solid tumors, Alzheimer's disease, and markers for screening of hypoxic metabolically active cells.

ACHIEVEMENTS

• Identified the first small molecule anti-cancer agent against paclitaxel resistant cancer cells.

• Developed a prototype of boronic acid-based fluorescent saccharide sensor for detection of gastrointestinal cancer.

• Designed indolo-pyrido-isoquinolin-based synthetic alkaloid that inhibits growth, invasion, and migration of breast cancer cells via activation of p53-miR34a axis.

• Book: *Molecular Materials: Preparation, Characterization, and Applications*. Sanjay Malhotra, B. L. V. Prasad, Jordi Fraxedas.

L-R: Husam Babikir, Meenakshi Malhotra, Rayhaneh Afjei, Tarik Massoud

Lab of Experimental and Molecular Neuroimaging

Tarik Massoud, MD, PhD

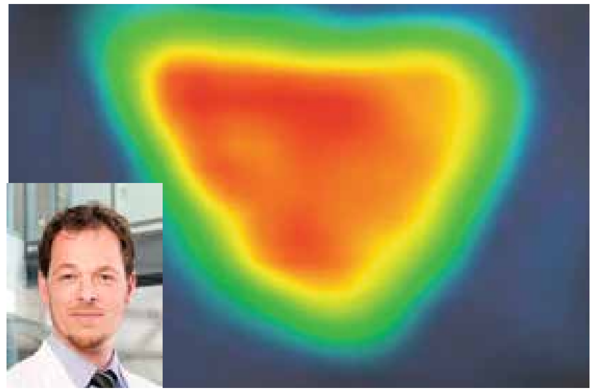
Our lab focuses on molecular and translational imaging of the brain, especially in neuro-oncology. We develop experimental and molecular imaging techniques for theranostic applications in brain cancer, especially in glioblastoma (GBM), to interrogate cellular and molecular biological events, and to use in new anti-cancer therapeutic strategies. This includes *in vivo* imaging of gene expression using reporter assays, protein-protein interactions, and signal transduction, as well as cellular and nano-imaging. Other interests relate to animal modeling of gliomas, new glioma radiotracer development, studying the GBM p53 transcriptional network, imaging protein folding and misfolding in cancer, and developing novel nanoparticle-based drug and microRNA formulations for ultra-targeted therapeutic strategies in endovascular neuro-oncology applications.

ACHIEVEMENTS

• Development of a novel molecular biosensor based on split reporter gene technology to image p53 protein folding in cancer, for ultimate use in the discovery of new anti-misfolding drugs.

• Development of novel strategies to package therapeutic microRNAs in colloidal nanoparticles delivered to glioblastomas.

• Development of novel approaches for combined microRNA and drug therapies to treat and image glioblastomas via novel routes, e.g., intranasa.



Clinical Application of Advanced Cardiac Imaging

Koen Nieman, MD, PhD

The objective of Dr. Nieman's research is the development of accurate diagnostic techniques and more effective pathways to improve the management of patients with cardiovascular disease. Ongoing research includes: (1) randomized controlled trials on tiered, comprehensive cardiac CT protocols for stable chest pain, and CT angiography (CTA) for the triage of acute chest pain in the emergency room, (2) new functional cardiac CT applications such as stress myocardial perfusion imaging, and CTA-derived fractional flow reserve, (3) characterization of atherosclerotic plaque, (4) contrast media, and (5) 4D flow imaging with cardiac MRI.

ACHIEVEMENTS

- Since his arrival late in 2016, Dr. Nieman has been working closely with the Cardiovascular Imaging Division in Radiology and with Cardiovascular Medicine in the Department of Medicine.
- 4D MR flow imaging in structural heart disease as shown in the image above depicting systolic flow across aortic valve. Int J Cardiovasc Imaging (2016) 32:301–307.
- Functional cardiac CT applications for the hemodynamic interpretation of CAD.
- Clinical validation of cardiac CT in cardiovascular medicine.
- Comprehensive evaluation of patients with symptoms after coronary revascularization.
- Cardiac CT in structural heart disease.

L-R: Rammohan Devulapally, Thillai Sekar Veerapazham, Ramasamy Paulmurugan, Sung-Bae Kim, Jessica Elizabeth Zuniga

Cellular Pathway Imaging Lab

Ramasamy Paulmurugan, PhD

The main focus of CPIL is to develop *in vivo* imaging strategies to study cellular signal transduction networks in cancer. Specifically, we study the signal transduction networks involved in estrogen receptor (α and β)/hormone interactions, epigenetic histone methylations, Nrf2-Keap1, Wnt-β-catenin, and NFkB-Nrf2 regulatory pathways and their roles in the pathogenesis and therapeutic responses of different cancers to various therapeutic interventions and drug resistance. Additionally, we develop microRNA mediated reprogramming approaches to enhance cancer chemotherapy. With regard to breast cancer, we investigate the possible association of microRNAs with breast cancer development and tamoxifen resistance in particular. We also study signaling pathways to establish immunotherapy for cancer.

ACHIEVEMENTS

- Developing multiplex-imaging assays to simultaneously measure histone methylations in various lysine marks of histone proteins.
- Developing FDA-approved polymer nanoparticles to co-deliver therapeutic sense- and antisense-microRNAs for cancer therapy.
- Studying estrogen receptor (ER) α and β cross talk in breast cancer.
- Nrf2-Keap1 antioxidant mechanism in drug resistance and chemotherapy in cancers.
- Studying the role of stem cells in cancer and targeting Wnt-Beta catenin and NFkB-Nrf2 signaling to improve cancer chemotherapy.

L-R: Antonio Benayas Hernandez, Jinghang Xie, Ke Jiang, Jianghong Rao, Guosheng Song, Tingting Dai, Jerry Cheng, Xianchuang Zheng, Xue Wu, Sarah Cui, Aiguo Song, Laura Chen, Min Chen, Susan Singh

Cellular and Molecular Imaging Lab

Jianghong Rao, PhD

The Rao lab is engaged in the quest for novel molecular imaging techniques to be ultimately deployed for patients at bedside, thus contributing to the detection and treatment of human diseases. Cost-effective, non-invasive, low dose molecular probes are the tangible output and the reason to be part of the Rao lab, working both from the fundamental and applied standpoints. Among the latest research results accomplished, we must emphasize the development of a new approach, Target Enable in Situ Ligand Aggregation (TESLA), for detection of intracellular apoptosis *in vivo*, through a biocompatible condensation reaction, photoswitchable nanoparticles for background-removing photoacoustic imaging, and also the novel nanoparticle sensors for detection of reactive oxygen species induced by radiation therapy.

ACHIEVEMENTS

- A patent was granted on 2016 on novel molecular probes for specific imaging and detection of mycobacteria species.
- Dr. Antonio Benayas Hernandez received a 2016 MSCA (Marie Sklodowska-Curie Action) fellowship from the European Commission. Dr. Benayas joined the Rao lab in April 2017, to develop a 20-month research project in new photoacoustic probes.
- Dr. Jinghang Xie; 2017 Molecular Imaging Young Investigator Prize.
- Graduate student Tingting Dai; 2016 Edward Curtis Franklin Fellowship.

Front row L-R: Nynke Sjoerdtje van den Berg, Zhen Qiu, Pranav Hedge, Eben Rosenthal, Elissa Capes, Tarn Teraphongphom, Nicholas John Oberhelman; Back row L-R: Steve Hong, Robert Ertsey, Ashley Zhu, Guolan Lu, Mika Michele Tabata

Translational Cancer Imaging Lab

Eben Rosenthal, MD

The Rosenthal lab focuses on development and clinical translation of novel imaging probes and multimodal imaging strategies for improving cancer detection and treatment. Our recent research has been mainly working towards first-in-human clinical trials using near-infrared labeled antibodies (cetuximab, panitumumab) for surgical and pathological navigation during the surgery of head and neck cancer, brain cancer, and pancreatic cancer. We are also studying the role of optical imaging for quantification of antibody accumulation and distribution in the tissue and developing noninvasive imaging biomarkers to identify patients amenable to targeted therapy.

ACHIEVEMENTS

- Two internal grants: 2016 Stanford nano shared facilities (SNSF) Bio/Medical Seed Grant and 2016 CCNE-TD Pilot Project 2.
- Three first-in-human clinical trials for evaluation of fluorescently labeled antibody as an optical agent used during surgery to detect head and neck cancer, malignant glioma, and pancreatic cancer.
- Initiation of GMP manufacture and IND application of radiolabeled panitumumab for clinical work.
- Dr. Tarn Teraphongphom received a Student Travel Stipend Award, a Women in Molecular Imaging Network Scholar Award, and an Industry Selected Poster Award from 2016 WMIC.
- Sarah Miller received a Poster Award from the Medical Student Research Symposium at Stanford.

L-R: Ahmed Hussein, Toni Benevento, Jing Wang, Roxanna Shabahang, Avnesh Thakor, Mehdi Razavi, Tiger (Gang) Ren, Olivia Deitcher

Thakor Lab

Avnesh Thakor, MD, PhD

Our laboratory's research primarily focuses on the pancreas. We conduct research related to diabetes by investigating beta cell regeneration using mesenchymal stem cells with the use of pulsed focused ultrasound for mesenchymal stem cell homing, islet cell transplantation, and the construction of novel "active" bioscaffolds for islet transplantation. We also study pancreatic cancer by developing novel intra-arterial delivery techniques to the pancreas and the synthesis of theranostic nanoparticle platforms.

ACHIEVEMENTS

- Development of novel techniques for intra-arterial delivery of therapeutics to the pancreas in rodent models.
- New strategies for islet co-transplantation with mesenchymal stem cells.
- Development of novel bioscaffolds for islet transplantation.
- Development of Raman nanoparticles that can detect oxidative stress which are targeted to pancreatic cancer.

Front row: Pan Li; Back row L-R: Taehwa Lee, Hersh Sagreiya, Ahmed El Kaffas, Ankush Swarnakar, Rammohan Devulapally, Huaijun (Morgan) Wang, Zhongqian Hu, Passa Pungchai, Sunitha Bachawal, Juergen Willmann, Jocelyn Steffen, Dandan Li, Katheryne Wilson, Isabelle Durot; Not pictured: Lotfi Abou-Elkacem, Alireza Akhbardeh, Joseph Chen, Shaya Zarkesh

Translational Molecular Imaging Lab

Juergen Willmann, MD

The Willmann lab develops and tests ultrasound molecular imaging for identifying and monitoring diseases with the goal of using this approach in the clinic for improved patient management. This novel imaging modality uses intravascular contrast microbubbles which are modified to bind to regions of the diseased vasculature expressing unique proteins. Using these microbubbles, we can detect small foci (<1 mm) of pancreatic and breast cancer and can monitor regions of diseased bowel undergoing active inflammation. We have also successfully explored their use as a drug delivery vehicle for cancer therapy. Finally, our lab has performed the first-in-human clinical trial using these novel contrast agents in women with ovarian and breast cancer.

ACHIEVEMENTS

- Lab member honors: Katheryne Wilson, PhD: 2017 Molecular Imaging Young Investigator (MIYI); Sayan Mullick Chowdhury, PhD: 2016 RSNA Introduction to Academic Radiology for Scientists Program, 2016 WMIC Best Pre-Clinical Paper; Ahmed El Kaffas, PhD: RSNA 2nd place Best Poster Award, 2016 WMIC Industry Selected Abstract Award.
- Published first-in-human clinical trial results on KDR-targeted ultrasound molecular imaging.
- Performed first-in-human clinical trial: 3D liver perfusion imaging with ultrasound in patients and preclinical 3D perfusion imaging studies to predict treatment response.
- First-in-human study on ultrasound spectroscopy in patients with hepatocellular carcinoma (HCC); also developed an imaging-guided drug delivery approach for therapy of HCC.
- Three new clinical trials on ultrasound molecular imaging of pancreatic, breast, and ovarian cancer.

Front row L-R: Xulei Qin, June Rhee, Xin Zhao, Loan Nguyen, Angelos Oikonomopoulos, Youngkyun Kim, Benjamin Chao, Won Hee Lee, Ilanit Itzhaki, Saereh Khanamiri, Alexa Wnorowski; Back row L-R: Lei Tian, Tomoya Kitani, Mingtao Zhao, Haodong Chen, Huaxiao Yang, David Paik, Sekyoung Oh, Haodi Wu, Chun Liu, Jared Churko, Nazish Sayed, Timon Seeger, Jaecheol Lee, Joseph Wu, Oscar Abilez, Mark Smeets, Kevin Lam, Ningyi Shao, Evgenios Neofytou, Vincent Wo, Yongjun Wang, Yang Zhou, Hongchao Guo, Ning Ma, Edward Lau, Henry Zhu, Mark Chandy, Yongjun Wang, Yonggang Liu, Joe Zhang, Sang Ging Ong.

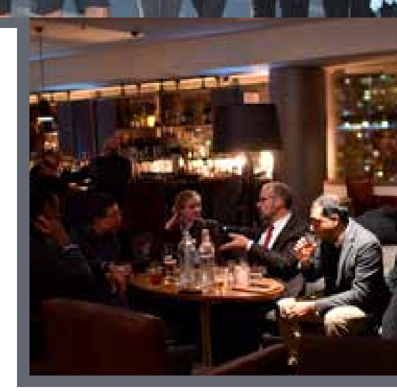
Cardiovascular Stem Cell Lab

Joseph Wu, MD, PhD

The Wu lab studies the biological mechanisms of adult stem cells, embryonic stem cells, and induced pluripotent stem cells. We use a combination of next generation sequencing, tissue engineering, physiological testing, and molecular imaging technologies to better understand stem cell biology *in vitro* and *in vivo*. For adult stem cells, we are interested in monitoring stem cell survival, proliferation, and differentiation. For embryonic stem cells, we are currently studying their tumorigenicity, immunogenicity, and differentiation. For induced pluripotent stem cells, we are interested in cardiovascular disease modeling, drug screening, and cell therapy. We also develop novel vectors and therapeutic genes for cardiovascular gene therapy applications.

ACHIEVEMENTS

- Performed "clinical trial in a dish" using patient-specific iPSCs to understand drug cardiotoxicity.
- Human-induced pluripotent stem cell–derived cardiomyocytes recapitulate the predilection of breast cancer patients to doxorubicin-induced cardiotoxicity.
- Demonstrated modeling of congenital heart disease (left ventricular non-compaction) with disease-specific iPSCs.
- Developed a comprehensive TALEN-based knockout library for generating human iPSC-based models for cardiovascular diseases.



Clockwise from top left: 2016 MIPS Retreat, 2016 Digital CT opening, 2016 WMIC, 2016 MIPS Retreat, 2016 Canary Challenge, 2016 RSNA, 2017 Holiday Party, 2017 Holiday Party, 2016 RSNA, 2016 Canary Challenge.

Feature

The Richard M. Lucas Center for Imaging

The Richard M. Lucas Center for Imaging is one of the few centers in the world with major centralized resources devoted to research in magnetic resonance imaging (MRI), magnetic resonance spectroscopy (MRS), and X-ray/CT imaging. The Center has pioneered MRI/MRS/X-ray/CT technology while developing new techniques that benefit patients with stroke, cancer, heart disease, and brain disorders. The Center, dedicated to imaging research, houses four GE whole-body MRI systems (three 3.0T, one 7.0T) and occupies 37,000 square feet on the Stanford campus. The Lucas Center also houses data analysis laboratories, an electronics laboratory/machine shop, and office space. The Lucas Center offers MRI access to hundreds of researchers, both within and outside the Department of Radiology. All researchers are trained in magnet safety and scanner operations by the magnet manager or MR research technologists.

The 3T3 GE Discovery 750 MRI scanner located at the Lucas Center. The MRI system includes 32 channel RF coils and multinuclear spectroscopy, and provides advanced capabilities to support functional brain imaging, and imaging of the abdomen and the musculoskeletal system.

HIGHLIGHTS INCLUDE:

Neuro MR Imaging: Neuroimaging studies at Lucas are led by research groups from Radiology, Psychiatry, Psychology, Anesthesiology, Neurology, and others. Their research investigations include stroke, Alzheimer's disease, Parkinson's disease, mild cognitive impairment, obsessive compulsive disorder, chronic pain, learning disorders, anxiety and depression, bipolar disorder, schizophrenia, and autism, among others. Imaging studies are also being conducted to monitor post-treatment by focused ultrasound (FUS) of the brain for essential tremor (ET) and to monitor cerebral perfusion during heart surgery.

Musculoskeletal MR Imaging: Imaging research is also conducted in the areas of joint disease for evaluation of osteoarthritis, rheumatoid arthritis, treatments for bone marrow lesions, improvements in arthroscopic surgery, evaluation of anterior cruciate ligament (ACL) injury, and many others. Pediatric studies include monitoring of treatments for muscular dystrophy, whole body cancer staging, and the differentiation of bone sarcomas vs. osteomyelitis.

Breast MR Imaging: Advances in imaging research of breast cancer and disease include development of non-contrast screening methods, diagnostic imaging, and staging approaches using dynamic contrast-enhanced perfusion, diffusion, and T2 imaging, all at considerably higher spatial resolution than the current standard-of-care. Image-guided biopsy techniques using advanced visualization methods, including augmented reality, are being developed and tested.

Abdominal and Pelvis MR Imaging: Imaging of the abdomen is conducted to monitor pharmaceutical treatments and to improve early detection of a variety of diseases including splenomegaly, myelofibrosis, insulin resistance, and NASH (non-alcoholic steatohepatitis). Prostate imaging is conducted to monitor treatment by focused ultrasound for localized low and intermediate risk prostate cancer.

Focused Ultrasound Treatments Guided by MR Imaging: Clinical trials are conducted at the Lucas Center using MR-guided focused ultrasound (MRgFUS) to treat bone metastasis, essential tremor, and soft tissue sarcomas. A recently installed 220 kHz FUS neuro system will be used to develop techniques to temporarily and sufficiently open the blood-brain barrier for drug delivery to metastatic brain tumors.

Hyperpolarizer: Hyperpolarized ^{13}C MR spectroscopy (MRS) is a functional MR technique for probing *in vivo* perfusion and metabolism with injection of hyperpolarized substrates. Studies include the assessment of glycolysis, oxidative phosphorylation, and other key metabolic pathways, optimized mapping of ^{1}H metabolite distributions throughout the body, and quantifying neurotransmitter levels and cycling rates in the brain.

DIVISION LEADERSHIP

Kim Butts Pauly, PhD (2014–Present)
Gary Glover, PhD (1990–2017)

SELECTED FUNDING

Comprehensive MRI near Total Joint Replacements. NIH/NIBIB 5 R01 EB017739 04 (Hargreaves)

Advancing Precision Health: Enabling Personalized Diagnostics and Treatment Delivery. Philips Semiconductors (Moseley)

Robust 1H MRSI of GABA, Glutamate, Glutamine, and Glutathione. NIH/NIMH 1 R01 MH110683 01A1 (Spielman)

Integration of Diffusion MRI Fiber Tracking and CLARITY 3D Histology for Improved Neurosurgical Targeting. NIH/NINDS 5 R01 NS095985 02 (McNab)

High Sensitivity Flow Imaging of the Human Placenta with Coherence-Based Doppler Ultrasound. NIH/NICHD 5 R01 HD086252 03 (Dahl)

MR-guided Focused Ultrasound Neuromodulation of Deep Brain Structures. NIH/NIMH 5 R01 MH111825 02 (Butts Pauly)

Center for Advanced Magnetic Resonance Technology at Stanford (CAMRT). NIH/NIBIB 5 P41 EB001589 23 (Glover)

SELECTED PUBLICATIONS

Sveinsson B, Chaudhari AS, Gold GE, Hargreaves BA. A Simple Analytic Method for Estimating T2 in the Knee from DESS. Magnetic Resonance Imaging. 2017 May; 38: 63–70. PMCID: PMC5360502.

Holdsworth SJ, Rahimi MS, Ni WW, Zaharchuk G, Moseley ME. Amplified Magnetic Resonance imaging (aMRI). Magnetic Resonance in Medicine, 2016 Jun; 75(6):2245–2254.

Park JM, Spielman DM, Josan S, Jang T, Merchant M, Hurd RE, Mayer D, Recht LD. Hyperpolarized (13)C-Lactate to (13) C-Bicarbonate Ratio as a Biomarker for Monitoring The Acute Response of Anti-Vascular Endothelial Growth Factor (anti-VEGF) Treatment. NMR Biomedicine, 2016 May; 29(5):650–659. PMCID: PMC4833516.

Leuze C, Aswendt M, Ferenczi E, Liu CW, Hsueh B, Goubran M, Tian Q, Steinberg G, Zeineh MM, Deisseroth K, McNab JA. The Separate Effects of Lipids and Proteins on Brain MRI Contrast Revealed Through Tissue Clearing. NeuroImage, 2017 Aug 1;156:412–422. PMCID: PMC5548623.

Li Y, Hyun D, Abou-Elkacem L, Willmann J, Dahl JJ. Visualization of small-diameter vessels by reduction of incoherent reverberation with coherent flow power Doppler. IEEE Transactions on Ultrasonics, Ferroelectrics and Frequency Control, 2016 Nov; 63(11):1878–1889. PMCID: PMC5154731.

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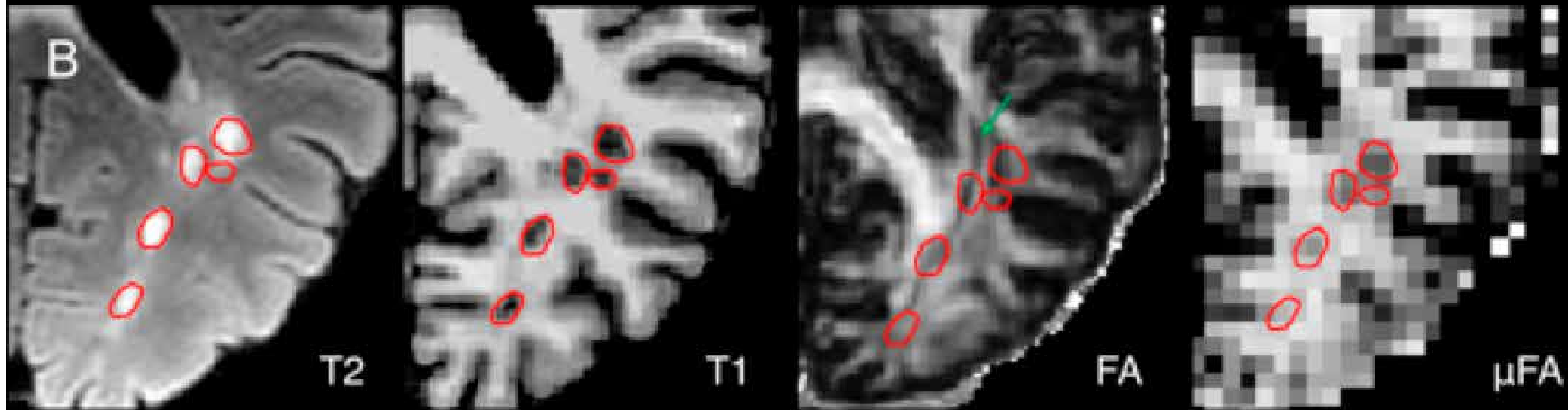


Radiological Sciences Laboratory (RSL)

The Radiological Sciences Laboratory presently comprises nine faculty and approximately 60 graduate and postdoctoral trainees, research staff, and others devoted to advancing imaging technology for diagnostic, basic science and therapeutic applications within the department and in collaborations across campus and beyond. Our research foci include the imaging modalities of MRI, CT, X-ray, PET, ultrasound imaging and MR imaging-guided focused ultrasound therapy. In addition to its basic and applied research, the RSL administers the Lucas MRI Service Center, which is in its 25th year of operation offering research scan capabilities to the local and extended community. Many of RSL's members at both faculty and trainee levels achieve high international distinction with awards and honors. For example, RSL, which includes the RSL Division and many of its Radiology collaborators, includes four past presidents of the International Society for Magnetic Resonance in Medicine, a distinction unique in the world. Besides exceptional research and collaboration, a high priority for the RSL is the training of the next generation of scientists and engineers, who derive from many departments within the schools of engineering, medicine, humanities and sciences, and law. In addition, our faculty and their students and fellows teach a variety of highly-regarded biomedical imaging courses including didactic classes, lab work, and seminars.

ACHIEVEMENTS

- Rapid acquisition and quantitative T2-mapping: a 5-minute, 3D knee MRI exam, in Stanford Clinic. (Hargreaves).

- Three-fold reduction in Artifact-Corrected MRI scans in subjects with Joint Replacements, in Stanford Clinic. (Hargreaves).

- Developed a novel and unique way to study the tissue motions in brain, liver, and tumors caused by cardiac and arterial pulsations (Moseley).

- Developed robust new ^{1}H-MRS approach for measuring GABA, glutamate, glutamine, and glutathione in the human brain (Spielman).

- Identified new hyperpolarized ^{13}C MRS probe, ^{13}C-labeled glycerate for measuring glycolysis *in vivo* (Spielman).

1st row L-R: Morteza Mohammadjavadi, Jan Kubanek, Victoria Yuan; 2nd row L-R: Kim Butts Pauly, Aurea Pascal-Tenor; 3rd row L-R: Taylor Webb, Pooja Gaur: 4th row L-R: Ron Watkins, Ningrui Li; 5th row L-R: Patrick Ye, Steve Leung; Not pictured: Rachelle Bitton

Focused Ultrasound (FUS) Lab

Kim Butts Pauly, PhD

When ultrasound is focused deep in the body, high intensities can be achieved without effect to intervening tissues. MR-guided focused ultrasound (MRgFUS) can be used to ablate tissue, such as in the case of cancer ablation. It can be used in combination with microbubbles to open the blood-brain barrier, or alone for ultrasound-based neuromodulation. We are developing methods for guiding these procedures, investigating the bioeffects from the ultrasound, and looking at ways to improve the efficacy of these procedures. A major focus of the lab is improving treatment planning beam simulations by measuring the acoustic parameters as a function of imaging parameters, both CT and MR. Simulations are then validated against MR thermometry and MR-ARFI *in vivo*.

ACHIEVEMENTS

- Victoria Yuan received a Bio-X summer fellowship.
- Kim Butts Pauly received a Brain Initiative grant.
- Patrick Ye received a Siebel Scholars fellowship.
- Steven Leung received a Siebel Scholars fellowship.
- Pooja Gaur received a SCIT fellowship.

Front row L-R: Leah Brickson, Jasmine Shu, You "Leo" Li; Back row L-R: Jeremy Dahl, Rehman Ali, Carl Herickhoff, Kevin Looby, Dongwoon Hyun; Not pictured: Arsenii Telichko, Marko Jakovljevic, Fuad Nijim

Ultrasonic Imaging Research Lab

Jeremy Dahl, PhD

Our lab develops and implements ultrasonic beamforming and imaging methods and has been focusing on the difficult-to-image patient. More recently, we have been developing high sensitivity applications based on coherence beamforming for flow imaging and molecular imaging. We have developed theories and estimation strategies to limit the computational effort of these coherence-based techniques in order to build these imaging methods into real-time imaging systems. We have used our real-time coherence-based imaging system in clinical and preclinical studies, including cardiac imaging, liver imaging, flow imaging in the placenta, and molecular imaging of early cancer.

ACHIEVEMENTS

- Dongwoon Hyun successfully defended his PhD thesis on "Efficient Spatial Coherence Estimation for Improved Endocardial Border Visualization in Real-Time."
- PhD student Rehman Ali received a four year NDSEG fellowship to study speed of sound estimation techniques with pulse-echo ultrasound.
- We developed a real-time ultrasound imaging system to implement harmonic coherence imaging and successfully applied it to stress echocardiagraphy patients.
- We developed angular coherence theory for ultrasound and applied it to implement a fast coherence beamforming method.

L-R: Jonathan Goodman, Haisam Islam, Jingyuan Chen, Allyson Rosen, Amy Sentis, Seul Lee, Christine Law, Patricia Lan, Allie Lee, Xue Zhang, Annie Jwa, Gary Glover

Functional Neuroimaging Lab

Gary Glover, PhD

Obtaining a fuller understanding of how the brain performs cognitive processing has fostered intense investigation because of its importance in health and disease. Our group is developing better tools for visualizing cognitive processing with functional magnetic resonance imaging (fMRI), a goal that is challenging because the signals are weak and easily obscured by on-going physiological processes, such as breathing and cardiovascular function. Our acquisition and processing methods are in widespread use by many investigators, including contributions to multimodal neuroimaging to obtain greater information (e.g., PET-fMRI, EEG-fMRI), and neuromodulation to causally perturb brain function to gain deeper understanding (e.g., with transcranial magnetic stimulation or transcranial electric stimulation). We seek to obtain higher sensitivity and specificity, while illuminating the neurobiological underpinnings of fMRI signals.

ACHIEVEMENTS

- Understanding the nature of high temporal frequency brain fluctuations.
- Developing more efficient fMRI acquisition methods that reduce signal dropout for better depiction of frontal brain regions.
- Developing fMRI methods to enable more precise targeting for ablative therapies for essential tremor patients.
- Showing the neurobiological correlates of impulse control in subjects.
- Demonstrating the use of biofeedback with real-time fMRI to reduce intensity and salience of chronic pain in patients.

L-R: Uche Monu, Audrey Fan, Sachin Sharma, Nate Safran, Feliks Kogan, Garry Gold, Marianne Black, Mary Hall, Kate Young, Lauren Watkins, Brian Hargreaves, Frank Chavez, Serena Bonaretti; Not pictured: Jimmy Yoder, Bragi Sveinsson, Akshay Chaudhari

Joint and Osteoarthritis Imaging with Novel Techniques

Garry Gold, MD

The JOINT lab's research is focused on improving imaging of musculoskeletal conditions including osteoarthritis. We would like to detect disorders at an early stage when intervention is more likely to be successful. Our work improves detection of musculoskeletal disease as well as functional imaging of bones, muscles, and joints under loaded conditions. Current projects include advanced MR imaging of early osteoarthritis, multimodality molecular imaging of joint degeneration and pain, improved imaging around metal, and new methods of imaging the joint using weight-bearing CT. We are also exploring the use of gait retraining to treat osteoarthritis.

ACHIEVEMENTS

- Published first PET-MRI study of osteoarthritis to image early changes in bone remodeling in the disease [2017 Lodwick Award Winner for best paper in musculoskeletal radiology, biology, or physiology; Garry Gold, MD].
- Implemented a new, rapid, high resolution knee scanning sequence at Stanford clinics for evaluation of a 5-minute knee MRI protocol.
- Dr. Gold served as the President of the International Society of Magnetic Resonance in Medicine (ISMRM) and was named a Fellow of the American Institute of Medical and Biological Engineering.
- Graduate students Bragi Sveinsson, Uche Monu, and Akshay Chaudhari successfully defended their Theses.

Front row L-R: Uche Monu, Yuxin Hu, Umit Yoruk, Philip Lee, Marianne Black, Kate Young, Steffi Perkins, Xinwei Shi, Frank Chavez; Back row L-R: Evan Levine, Akshay Chaudhari, Hans Weber, Bragi Sveinsson, Garry Gold, Daehyun Yoon, Brian Hargreaves

Body MRI Research Group

Brian Hargreaves, PhD

Our research links basic science with clinical practice and industry product development to broadly impact patient care. We focus on MRI of breast cancer, abdominal MRI, and orthopedic MRI. High-resolution images improve diagnosis of breast lesions and enable detection of smaller lesions, while use of multiple contrast images improves discrimination of different cancer types. Rapid abdominal imaging is essential to avoid problems from respiratory, cardiac or digestive motion. We support fast techniques that are used in almost every body or breast imaging scan at Stanford Hospital. In orthopedic MRI, we aim to shorten knee MRI to 5–10 minutes while offering quantitative information to study development of osteoarthritis. Finally, we have led development of robust MRI in the presence of metal, resulting in techniques to help assess complications with joint replacements, spinal fixation hardware, or other metal devices that are increasingly present in imaging subjects.

ACHIEVEMENTS

• Substantially reduced MRI exam times for patients who have implanted metal hardware, as well as enabling MR-guided focused ultrasound (MRgFUS) surgery for patients with metal devices.

• Demonstrated near-equal performance of a fast, 5-minute knee MRI protocol, which could replace 20–30 minute exams and improve access to MRI while lowering cost.

• Used an automated approach to quantifying kidney function using MRI.

• Working with Microsoft to enable surgeons to see lesions inside patients using the HoloLens mixed-reality glasses.

• Hans Weber was given the prestigious "Junior Fellow" award. Brian Hargreaves was selected as a Biodesign Faculty Fellow, and completed this 5-month program in May 2017.

L-R: Manuela Vasquez, Grant Yang, Qiyuan Tian, Christopher Leuze, Sam Cartmell, Jennifer McNab

Lab for Ultra-High-Field MRI of Human Brain Microstructure

Jennifer McNab, PhD

The central mission of the McNab lab is to develop the next generation of MRI techniques that probe the structural and functional architecture of the human brain. This requires new MRI contrast mechanisms, strategic encoding/reconstruction schemes, brain tissue modeling and validation. Our current research is focused on the development of MRI pulse sequences and analysis strategies that capitalize on the benefits of ultra-high-field (7T) MRI and stronger and faster magnetic gradient technology. Current projects include the development of new methods for lesion characterization, neurosurgical targeting, mixed reality neuronavigation and MRI validation using CLARITY 3D histology.

ACHIEVEMENTS

• Developed clinically feasible double diffusion encoding for improved characterization of multiple sclerosis lesions.

• Demonstrated clinical value in diffusion tractography-based targeting for treatment of essential tremor with MR-guided focused ultrasound (MRgFUS).

• Demonstrated mixed reality holographic visualization of MRI on top of a subject's head in the real world.

• Developed an MRI method that identifies granular cortices based on cerebral cortical fiber patterns.

• Improved capabilities for comparing MRI and CLARITY 3D histology in the same specimens.

Front row L-R: Yosuke Ishii, Greg Zaharchuk, Fabiola Bezerra de Carvalho Macruz, Jee Young Kim, Audrey Fan, Itamar Terem, Junshen Xu, Michael Moseley; Back row L-R: Soren Christensen, Tom Brosnan, Thomas Christen, Thor Thamm, Samantha Holdsworth, Enhao Gong, Jia Guo

Clinical Center for Advanced Functional Neuroimaging (CAFN)

Michael Moseley, PhD
Greg Zaharchuk, MD, PhD

CAFN develops and implements quantitative MRI tools to understand the basic foundations of the human brain, map neural anatomical and vascular microstructures via functional network connectivities, and thus precisely diagnose and treat complex neurological disease in individual patients. We foster interdepartmental and international collaborations focused on providing cutting-edge MR imaging to our patients. Our tools include high-resolution diffusion mapping of abnormal brain development and loss of function, rapid and non-contrast blood flow and oxygenation mapping, time-resolved connectivity of the brain's many networks, and resolving brain CSF and dynamics for intracranial pressure mapping. Our mission is to improve investigation and treatment of disorders of the nervous system.

ACHIEVEMENTS

• Developed a comprehensive array of novel non-contrast agent cerebral blood flow (CBF) methods for clinical diseases of the CNS.

• Created and applied a clinical time-resolved method to map the brain's neural circuitry and metabolic oxygenation in patients with CNS disease.

• Collaborated with LPCH to use PLURAL image processing to map 12 different brain functions from a single scan.

• Led a clinical adoption of high-resolution diffusion MRI protocols, all motion-corrected for advanced diffusion applications in the brain.

• Refined a functional network mapping workflow to perform a fully personalized patient brain network analysis within 60 seconds.

• Pioneered novel deep learning methods to predict, improve, and characterize brain imaging for diseases.

L-R: Jia Wang, Picha Shunhavanich, Paurakh Rajbhandary, Mats Persson, Marlys LeSene, Norbert Pel, Sarah Divel, Jinghui Wang, Robert Bennett; Not picture: Xiaoqing Li

Inverse Geometry CT and Conventional CT

Norbert Pelc, ScD

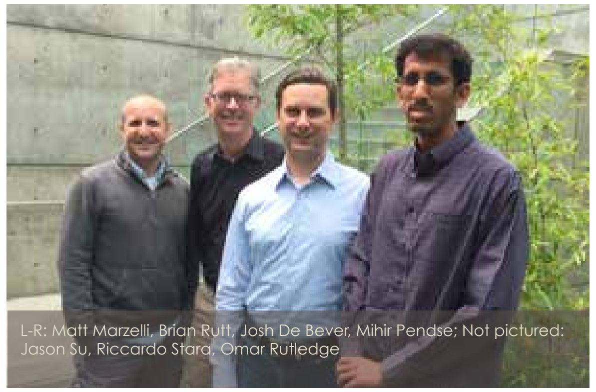
Computed Tomography (CT) has become an indispensable tool in diagnostic imaging and image guidance because of its reliability and high information content. Although the radiation dose per exam is modest, the high use means that population dose burden is high. We (and others) are working on technologies that could significantly reduce radiation dose, including more efficient detectors, reconstruction methods and systems. As part of this work, we are also exploring how to reduce the dose without decreasing the information content. In addition to this work on CT system design, we are also working to improve specific CT applications. In particular, we are developing methods to validate and optimize the measurement of brain perfusion with contrast-enhanced CT.

ACHIEVEMENTS

• We are completing construction of a piecewise-linear dynamic beam attenuator (bowtie filter).

• We demonstrated the system impact of charge sharing and cross-talk in photon counting X-ray detectors.

• We showed that much of the noise reduction with statistical image reconstruction can be achieved by image domain filtering.



L-R: Matt Marzelli, Brian Rutt, Josh De Bever, Mihir Pendse; Not pictured: Jason Su, Riccardo Stara, Omar Rutledge

Ultra-High-Field Magnetic Resonance Imaging Research Lab

Brian Rutt, PhD

The overall goals of the Rutt lab are to develop, optimize and exploit ultra-high-field (7T) whole body MRI in a variety of research applications, starting with the broad area of neuroimaging but progressing to other anatomical regions and applications. MR imaging at such high magnetic fields faces a number of significant technical challenges that have slowed its widespread application. The objectives of the group are to conceive, implement and apply novel strategies that solve these technical challenges, and then to develop methods that will enable routine high-quality MR imaging at 7T. Our longer term aim is to employ these technical developments to study fundamental structural, physiological, metabolic and functional changes associated with important human diseases of the brain and eventually other anatomical regions.

ACHIEVEMENTS

• Developed new parallel transmit MRI methods for 7T MRI.

• Developed new "focused RF" methodology for targeted hyperthermia.

• Designed, analyzed, and built high performance head gradient technology.

• Developed new sequences and post-processing methods that delineate thalamic nuclei and characterize T1 relaxation.

L-R: Zachary Corbin, Lawrence Recht, Daniel Spielman, Mette Hauge-Lauritzen, TJ Jang, Shie-Chau Liu, Meng Gu, Ronald Watkins, Milton Merchant, Gajanana Keshava Datta

The Spielman Lab for MRS and Multinuclear Imaging

Daniel Spielman, PhD

Medical imaging provides a wealth of information ranging from gross anatomy to biochemical processes. The Spielman laboratory focuses on the development of novel methods for the non-invasive imaging of metabolism and their translation to the clinic. Our current research efforts focus on using ^{1}H magnetic resonance spectroscopy (MRS) to measure neurotransmitter function and oxidative stress in the human brain and hyperpolarized ^{13}C MRS and PET imaging to study glucose metabolism in both small animal models and clinical patients. Active collaborations include studies of autism, schizophrenia, obsessive-compulsive disorder, cancer diagnosis and treatment monitoring, and metabolic diseases including diabetes and non-alcoholic steatohepatitis (NASH).

ACHIEVEMENTS

• Demonstrated the use of hyperpolarized ^{13}C-pyruvate to measure acute metabolic changes in glioma in response to anti-VEGF therapy.

• Developed robust new ^{1}H-MRS approach for measuring GABA (gamma-aminobutyric acid), glutamate, glutamine, and glutathione in the human brain.

• Identified new hyperpolarized ^{13}C MRS probe, ^{13}C-labeled glycerate for measuring glycolysis *in vivo*.

• Identified new hyperpolarized ^{13}C MRS probe, ^{13}C-labeled alanine for *in vivo* measurement of tissue redox state in the liver.

• Preparing for first-in-human PET-MR hyperpolarized ^{13}C-pyruvate studies of prostate and brain cancers.

Feature

The Project Baseline Study

Mapping Human Health and the Transition to Disease

Study Watch given to all participants to continuously monitor their health for the full term of the study. Note: The Study Watch is an investigational device and is not available for sale.

A landmark four-year study was launched in 2017, the Project Baseline study, as a collaboration between Verily (an Alphabet company), Stanford Medicine, Duke University School of Medicine, and Google to characterize human health with unprecedented depth and precision. At Stanford, the study is directed as a joint effort by the departments of Radiology and Medicine, led by Dr. Sam Gambhir (PI; Chair, Radiology) and Dr. Kenneth Mahaffey (Co-PI; Vice Chair of Clinical Research, Medicine).

The Project Baseline study is a quest to map human health through a comprehensive study of health and the transition to disease, including lung, breast, and ovarian cancer and cardiovascular disease. This multicenter longitudinal, prospective cohort study will collect and analyze an unprecedented breadth of data for a group of 10,000 participants representative of the diversity within the U.S. population. This study will characterize participants across clinical, molecular, imaging, sensor, self-reported, behavioral, environmental, and other health-related measurements from onsite visits, continuous data collection through sensor technology, and regular engagement via an online portal and mobile app.

Participants come to Stanford for five annual visits, which include 1–2 full days of study protocol-specific assessments at the initial visit. Biospecimens collected include blood, saliva, stool, swabs, tears, and urine, which will be analyzed along with clinical data acquired. Participants also wear an investigational study watch and use a sleep sensor to provide continuous monitoring of their health for the full term of the study. When integrated and compiled into a digital platform, the data will allow researchers to see values among a diverse population that was not previously possible, and hopefully provide biomarkers of disease-related transitions, particularly those related to cancer and cardiovascular disease.

Stanford enthusiastically hosted its first participant onsite on June 27, 2017. A distinguishing focus of the Project Baseline study is to engage participants with a seamless and positive experience throughout the four-year study, rather than merely regard them as research subjects. These efforts include a mobile app, a participant advisory counsel, in-person events, and return of results. The study is open to anyone across the health spectrum provided they meet basic eligibility criteria. The study has been reported extensively in the national media—*CNBC*, *Business Insider*, *Wired*, and *Fortune* to name a few, with thousands of potential participants registering in just a few days after study launch.

The Project Baseline study is envisioned to shift the paradigm of how health is viewed. Specific findings from the study may change the science of systems biology by understanding the variation in the "normal" population of many biomarkers and the transition from health to disease. Multi-dimensional analysis may enable an unprecedented comprehension of the relationships between individual assessments and related biological, physiological, and behavioral systems. In the long-term, the study could transform the current approach to healthcare and launch the next generation of medical practice into the era of precision health and integrated diagnostics.

The Project Baseline study team represents a truly collaborative initiative which includes faculty and staff from Stanford departments of Radiology, Medicine, and Ophthalmology, the Clinical and Translational Research Unit (CTRU), and the VA Palo Alto Health Care System.

www.projectbaseline.com

DIVISION LEADERSHIP

Sanjiv Sam Gambhir, MD, PhD
Ryan Spitler, PhD

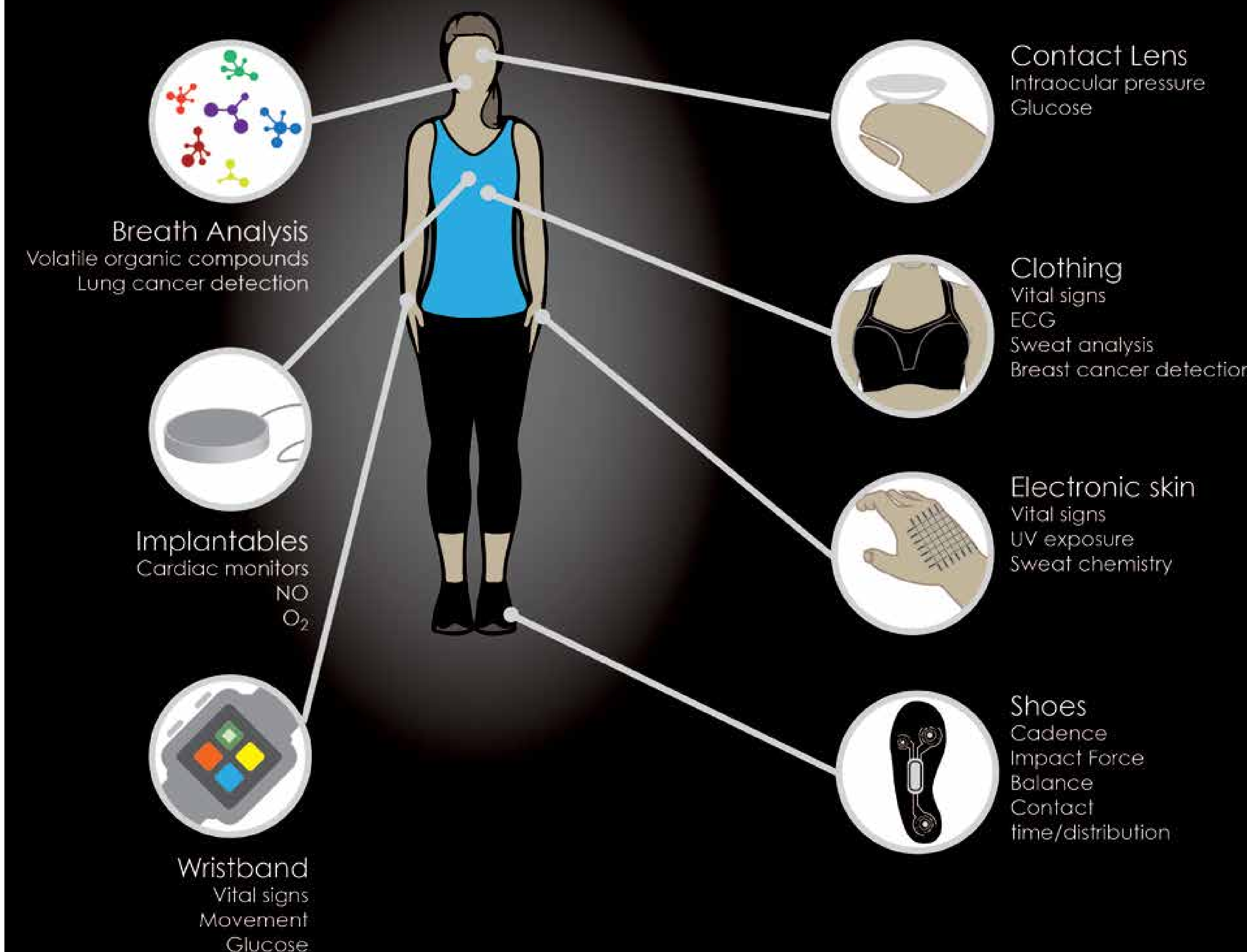
INAUGURAL ACTIVITY

The PHIND Center was officially launched in January 2017 and already has over 100 Stanford faculty interested in becoming members.

$1.5 million in seed grants to launch 10 Pilot Projects and two Dream Teams in 2017.

Creating the most in-depth library of human disease measures in history (Project Baseline study).

Formed an external scientific advisory board, composed of prominent Healthcare Leaders.



A selection of wearable and implantable devices are shown to demonstrate the variety of physiological and molecular parameters that can be measured.

Precision Health and Integrated Diagnostics (PHIND) Center at Stanford

The Precision Health and Integrated Diagnostics (PHIND) Center is the first center in the world focused on precision health and integrated diagnostics. The PHIND Center plays a critical role in mobilizing the components needed to advance this new vision of healthcare. It is developing, testing, and disseminating the next generation of healthcare mechanisms for precision health. Whereas precision medicine is focused on the treatment after the manifestation of disease, precision health is focused on early prediction and prevention of disease onset. The PHIND Center integrates diagnostic information collected from multiple sources both on the body, and in one's home. It also studies the fundamental biology underlying early transitions from health to disease and the associated biomarkers (molecules) of health and early disease. The new Center aims to fundamentally revolutionize healthcare leading to better and more productive lives for individuals by integrating several key areas. These areas include: (1) fundamental studies on the biology of disease formation to understand the earliest transitions from healthy humans, organs, and cells to a diseased state, (2) biomarker research to study molecules that indicate both healthy states and early signs of disease, and (3) diagnostic technology and information to accurately monitor and detect health changes early. This can be achieved by collecting information from multiple sources on the body and in the home, office or wider community.

Active Sponsored Research

as of August 31, 2017

NIH

Airan, Raag	RF1	Noninvasive Neuromodulation via Focused Ultrasonic Drug Uncaging
Butts Pauly, Kim	R01	MR-Guided Focused Ultrasound Neuromodulation of Deep Brain Structures
Butts Pauly/Pelc	T32 (MPI)	Predoctoral Training in Biomedical Imaging at Stanford University
Chin, Frederick	R21	A New Class of CSF-1R Radioligands for Monitoring Glioblastoma Progression and Therapy
Chin, Frederick	R01	Cross-Species Multi-Modal Neuroimaging to Investigate GABA Physiology in Fragile X Syndrome
Churko, Jared	K99	Notch Signaling in Cardiomyocyte Transcriptome Signatures
Dahl, Jeremy	R01	Improved Image Quality of Focal Liver Lesions Using the Coherence of Ultrasound
Dahl, Jeremy	R01	High Sensitivity Flow Imaging of the Human Placenta with Coherence-Based Doppler Ultrasound
Daldrup-Link, Heike	R21	Imaging Tumor Associated Macrophages in Bone Sarcomas
Daldrup-Link, Heike	R01	Personalized Whole Body Staging for Children with Cancer: A Solution to the Conundrum of Long-Term Side Effects from CT and PET-CT Scans
Daldrup-Link, Heike	R01	Monitoring of Stem Cell Engraftment in Arthritic Joints with MR Imaging
Datta, Keshav	F31	Improved Metabolic Imaging Using Hyperpolarized ^{13}C MR Substrates
Demirci/Cunningham	R01 (MPI)	Portable Nanostructured Photonic Crystal Device for HIV-1 Viral Load
Demirci/Kaye	R01 (MPI)	Platform Technology for Detection of Cancer-Associated Viruses in HIV Patients
Fleischmann, Dominik	R21	Cardiac Diffusion Imaging for Heart Transplant Surveillance
Gambhir, Sanjiv Sam	R01	A Novel Positron Emission Tomography Strategy for Early Detection and Treatment Monitoring of Graft-Versus-Host Disease
Gambhir, Sanjiv Sam	R01	Nanoparticle-Based Triple Modality Imaging and Photothermal Therapy of Brain Tumors
Gambhir, Sanjiv Sam	R01	Optimization of an Activatable Photoacoustic Agent to Image Thyroid Cancer
Gambhir, Sanjiv Sam	R01	Reporter Gene Technologies for Integrated Cancer Diagnostics
Gambhir/Felsher	U01 (MPI)	Modeling and Predicting Therapeutic Resistance of Cancer
Gambhir/Wang	U54 (MPI)	Center for Cancer Nanotechnology Excellence for Translational Diagnostics (CCNE-TD)
Glover, Gary	P41	Center for Advanced Magnetic Resonance Technology at Stanford
Gold, Garry	K24	Advanced MR Imaging of Early Osteoarthritis
Gold, Garry	R01	Osteoarthritis: Quantitative Evaluation of Whole Joint Disease with MRI
Gold, Garry	R01	Weight-Bearing Imaging of the Knee Using C-Arm CT
Hargreaves, Brian	R01	Comprehensive MRI Near Total Joint Replacements
Hargreaves, Brian	R01	Quantitative 3D Diffusion and Relaxometry MRI of the Knee
Hargreaves/Daniel	R01 (MPI)	High-Resolution Whole-Breast MRI at 3.0T
Hettie, Kenneth	F32	An ^{18}F PET/NIRF Smart Probe for Identifying, Grading, and Visualizing Astrocytic Gliomas
James/Longo	R21 (MPI)	New PET Imaging Agent for Monitoring Treatment Response in Alzheimer's Disease
Kubanek, Jan	K99	Ultrasonic Neuromodulation: From Mechanism To Optimal Application
Lee, Brian Jun	F31	RF-Transmissive PET Insert for Integrated PET-MRI
Levin, Craig	R01	Exploring a Promising Design for the Next Generation Time-of-Flight PET Detector
Levin, Craig	R01	RF-Penetrable PET Ring for Acquiring Simultaneous Time-of-Flight PET and MRI Data
Levin, Craig	T32	Stanford Molecular Imaging Scholars (SMIS)
Mallick/Gil	R01 (MPI)	A Discovery Engine For Reproducible and Comparable Multi-Omic Analysis
McNab, Jennifer	R01	Integration of Diffusion MRI Fiber Tracking and CLARITY 3D Histology for Improved Neurosurgical Targeting
Napel/Daniel	T32 (MPI)	Stanford Cancer Imaging Training (SCIT) Program
Napel/Plevritis	R01 (MPI)	Tools for Linking and Mining Image and Genomic Data in Non-Small Cell Lung Cancer
Napel/Rubin	U01 (MPI)	Computing, Optimizing, and Evaluating Quantitative Cancer Imaging Biomarkers
Pelc, Norbert	R21	Charge Cloud Tracker: A High-Resolution, High-DQE, Photon-Counting Energy Discriminating X-ray Detector
Pelc/Edic/Wang	U01 (MPI)	High Dose Efficiency CT System
Pitteri/Bertozzi	U01 (MPI)	Making Glycoproteomics via Mass Spectrometry More Accessible to the Greater Scientific Community
Plevritis, Sylvia	R25	Cancer Systems Biology Scholars Program
Plevritis/Clarke	U01 (MPI)	Clinically-Relevant Regulatory Networks in the Lung Tumor Microenvironment
Plevritis/Nolan	U54 (MPI)	Modeling the Role of Lymph Node Metastases in Tumor-Mediated Immunosuppression
Rao, Jianghong	R21	An Activatable PET Tracer for Imaging PARP-1 Activity in Breast Cancer
Rao, Jianghong	R01	Beta-Lactamase Fluorescent Probes for Bacterial Detection
Rao, Jianghong	R01	Nanoprobes for Imaging RONS and Drug-Induced Hepatotoxicity
Rao/Felsher	T32 (MPI)	Cancer-Translational Nanotechnology Training Program (Cancer-TNT)
Rubin, Daniel	U01	Qualification and Deployment of Imaging Biomarkers of Cancer Treatment Response

*Note, multiple PI (MPI) awards are listed only once. All partnering PI names are shown with contact PI as the lead name. Awards listed in alphabetical order by PI.

Soh/Demirci	R25 (MPI)	Canary Cancer Research Education Summer Training (Canary CREST) Program
Spielman, Daniel	R01	Imaging Brain Metabolism Using MRS of Hyperpolarized ^{13}C-Pyruvate
Spielman, Daniel	R21	Novel MRS Methods for Measuring Brain Energetics and Neurotransmitter Cycling
Spielman, Daniel	R01	Robust ^{1}H MRSI of GABA, Glutamate, Glutamine, and Glutathione
Spielman/Recht	R01 (MPI)	Metabolic Therapy of GBM Guided by MRS of Hyperpolarized ^{13}C-Pyruvate
Stoyanova, Tanya	R00	Proteolytically Cleaved Receptors as Oncogenes and Therapeutic Targets
Toumazis, Iakovos	F32	Personalized Dynamic Risk-Based Lung Cancer Screening
Vasanawala, Shreyas	R01	Rapid Robust Pediatric MRI
Vasanawala/Pauly	R01 (MPI)	Development and Translation of High Performance Receive Arrays for Pediatric MRI
Willmann, Juergen	R21	Molecular Spectroscopic Photoacoustic Imaging for Breast Lesion Characterization
Willmann, Juergen	R01	Quantification and Monitoring Inflammation in IBD with Molecular Ultrasound
Willmann/Dahl	R01 (MPI)	Automated Volumetric Molecular Ultrasound for Breast Cancer Imaging
Willmann/Dahl	R21 (MPI)	High Sensitivity Molecular Ultrasound Imaging in Pancreatic Cancer
Willmann/Dahl/ Paulmurugan	R01 (MPI)	Therapeutic miRNA Modulation of Hepatocellular Carcinoma Using Ultrasound Guided Drug Delivery
Willmann/Hristov	R01 (MPI)	3D Dynamic Contrast-Enhanced US for Monitoring Chemotherapy of Liver Metastasis
Willmann/Park	U01 (MPI)	Molecular Imaging Methods for the Detection of Pancreatic Ductal Adenocarcinoma
Willmann/Paulmurugan	R21 (MPI)	3D Passive Cavitation Imaging-Guided Therapeutic Delivery of MicroRNA into Cancer
Wilson, Katheryne	K99	Spectroscopic Photoacoustic Molecular Imaging for Breast Lesion Characterization
Winkler, Simone	K99	Human Connectome Mapping Using Ultra-High-Resolution MRI: A Technological Pathway
Wintermark, Max	R01	MR-Guided Focused Ultrasound Combined with Immunotherapy to Treat Malignant Brain Tumors
Wu, Joseph	T32	Multidisciplinary Training Program in Cardiovascular Imaging at Stanford
Wu, Joseph	R01	Genome Editing of Human IPSCs to Study Inherited Hypertrophic Cardiomyopathy
Wu, Joseph	R01	Assessment of Low-Dose Radiation Risk and Mechanisms of Individual Radiosensitivity
Wu, Joseph	R01	Molecular Imaging of Cardiac Pluripotent Stem Cells
Yeom/Moseley	R21 (MPI)	A 5 Minute Motion-Corrected Pediatric Brain MRI Protocol
Zaharchuk, Greg	R01	Imaging Collaterals in Acute Stroke (iCAS)
Zavaleta, Cristina	R21	A New Raman-Based Strategy to Identify Tumor Margins and Guide Surgical Resection
Zavaleta, Cristina	K22	A New Strategy for Cancer Detection Using Raman Spectroscopy with Nanoparticles
Zeineh, Michael	R01	Real-Time MRI Motion Correction System

NIH SUBCONTRACT AWARDS

Daniel, Bruce	UC Office of the President	Technologies for Augmented Reality Breast Surgery
Demirci, Utkan	Gaia Medical Institute	NEXT-GEN Oral Test for Monitoring HIV/AIDS in Point-of-Care
Demirci, Utkan	UCSF	Single Cell Characterization of Latent HIV-1 Reservoirs
Demirci, Utkan	U of Illinois	Rapid Disease Diagnostics Using Photonic Crystal Enhanced Antigen Biomarker
Gambhir, Sanjiv Sam	U Texas MD Anderson Cancer Center	Biospecimen Banking and Biomarker Validation for Lung Cancer Early Detection in Cohort Receiving Low Dose Helical Computed Tomography Screening
Glover, Gary	U Penn	Non-Invasive Neuromodulation Mechanisms and Dose/Response Metrics
Kothary, Nishita	U Penn	A phase 2 randomized multicenter trial to compare hepatic progression-free survival following bland embolization, lipiodol chemoembolization, and drug-eluting bead chemoembolization of neuroendocrine liver metastases
Langlotz, Curtis	U Wash	Natural Language Processing of Neuroradiology Reports
Levin, Craig	Ziteo Medical, Inc.	A Hand-Held PET Imaging Camera for Intra-Operative Use
Mallick, Parag	Ohio State U	High Performance Analytics and Unified Visual Platform for Integrating Genome, Proteome and Histology Images in Cancer Subtyping
Mallick, Parag	USC	L2K2R2: Learn to Read to Know, Know to Learn to Read
Mallick, Parag	USC	Towards Automating Discovery: Systematic Data Analysis of Science Repositories
McNab, Jennifer	UC Berkeley	Foundations of MRI Corticography for Mesoscale Organization and Neuronal Circuitry
Napel, Sandy	Kitware, Inc.	Accelerating Community-Driven Medical Innovation with VTK
Napel, Sandy	MGH	Informatics Tools For Optimized Imaging Biomarkers For Cancer Research & Discovery
Napel, Sandy	Vanderbilt U	Radiomics & Deep Learning Approaches for Screen Detected Lung Adenocarcinoma
Paulmurugan, Ramasamy	Mayo Clinic	Imaging of Mitochondrial Function of Progenitor Cells Transplanted to the Ischemic Myocardium
Butts Pauly, Kim	UCSD	Diffusion Imaging in Gray Matter
Pelc, Norbert	Georgia Tech	Volumetric CT Imaging Using Primary Modulation
Plevritis, Sylvia	Georgetown	Comparative Modeling: Informing Breast Cancer Control Practice and Policy
Plevritis, Sylvia	U Mich	Comparative Modeling of Lung Cancer Prevention and Control Policies
Rubin, Daniel	Leidos Biomed Research Inc.	AIM-DICOM SR Harmonization Project
Rubin, Daniel	Mt. Sinai Sch of Medicine	Genome-Wide Association Study of Mammographic Density
Rubin, Daniel	RSNA	Medical Image Sharing Through a Patient-Controlled Exchange System
Rubin, Daniel	RSNA	Unification of LOINC Radiology and the RadLex Playbook
Soh, H. Tom	UC Santa Barbara	Encode-Sort-Decode (ESD): Integrated System for Discovery of Non-Natural Affinity Reagents
Soh, H. Tom	UC Santa Barbara	Systems Biology of Coagulation and Trauma-Induced Coagulopathy

Spielman, Daniel	U Maryland	Metabolic Imaging of Nonalcoholic Fatty Liver Disease
Sze, Daniel	Vanderbilt U	Radiation-Emitting SIR-Spheres in Non-resectable (RESiN) Liver Tumor Registry
Vasanawala, Shreyas	U Wisconsin	Development and Validation of Quantitative MRI Biomarkers of Iron Overload
Willmann, Juergen	NuvOx Pharma LLC	B7-H3-Targeted Contrast Agent for Ultrasonic Detection of Breast Cancer
Willmann, Juergen	NuvOx Pharma LLC	Pancreatic Ductal Adenocarcinoma Targeted Ultrasound Contrast Agent Development
Wintermark, Max	Medical U of South Carolina	POSITIVE trial
Wintermark, Dr. Max	UCSF	Seizures in Pediatric Stroke (SIPS) II
Wintermark, Max	UCSF	The Vascular Effects of Infection in Pediatric Stroke Study
Wintermark, Max	U Cincinnati	NSTN National Clinical Coordinating Center

OTHER GOVERNMENT FUNDED PROJECTS

Demirci, Utkan	DoD	A Universal Platform for Identification of Novel Lung Cancer Biomarkers Based on Exosomes
Demirci, Utkan	U.S. Army	Biofidelic Three-Dimensional Brain Surrogate Models of MTBI-Induced Alzheimer's Disease Pathology
Demirci, Utkan	Jet Propulsion Lab	Magnetic Levitation-Mediated Microfluidic Platform (MLMP) for Rapid Spore Quantification
Demirci, Utkan	Natl Inst Justice	Automation of Differential Extraction with Sperm Quantitation Using Microfluidic-Integrated Shadow Imaging System for Forensic Applications
Demirci, Utkan	NSF	CAREER: Noninvasive fields for directed 3D microgel assembly for tissue engineering
Demirci, Utkan	NSF	Collaborative Research: EAGER: Biomanufacturing: Bioengineering of 3-Dimensional Brain Surrogate Tissue Models
Iagaru, Andrei	DoD	^{68}Ga Bombesin PET-MRI in Patients with Biochemically Recurrent Prostate Cancer and Noncontributory Conventional Imaging
Mallick, Parag	U.S. Dept. of Interior	Accelerating Knowledge Extraction from Large-Scale Multi-Data Sources by Incorporating Prior Knowledge with Deep Learning
Pitteri, Sharon	U.S. Army	Distinguishing Benign from Malignant Breast Lesions: Does Breast Interstitial Fluid Hold the Answers?
Rao, Jianghong	U.S. Army	PET Imaging Heparanase Activity in Metastatic Prostate Cancer in Tumor Xenografts
Soh, H. Tom	DARPA	Binder-Finder Through Machine-Learning (BFML)

INDUSTRY FUNDED PROJECTS

Cheng, Zhen	Infinitus (China) Company Ltd.	Molecular Imaging of Lipopolysaccharide on Immune Balance

Cheng, Zhen	Infinitus (China) Company Ltd.	Molecular Imaging of Treatment Response of Infinitus Products
Cheng, Zhen	Infinitus (China) Company Ltd.	Molecular Imaging Research of Slimming Waist Circumference Efficacy and Its Mechanism
Cheng, Zhen	Infinitus (China) Company Ltd.	Research on Visualization of Cancer Prevention and Early Mitigation Action
Cheng, Zhen	Lecoucou Group Holdings	Research on Mechanisms of Nature Products for Treatment of Drug Addiction
Chin, Frederick	Piramal Imaging SA	[^{68}Ga]RM2 ([^{68}Ga]-Bombesin) Manufacturing Agreement
Chin, Frederick	Piramal Imaging SA	Implementation of Revised Clinical-Grade [^{18}F]FSPG Radiochemistry for IND Approval
Dahl, Jeremy	General Electric Company	3D Acoustic Maps of Abdominal and Vascular Tissue for Modeling Acoustic and Shear Wave Propagation
Demirci, Utkan	Gaia Medical Institute	NEXT-GEN Oral Test for Monitoring HIV/AIDS in Point-of-Care
Demirci, Utkan	Philips Electronics North. America Corp	Advancing Precision Health: Enabling Personalized Diagnostics and Treatment Delivery
Fleischmann, Dominik	Siemens Medical Solutions USA, Inc.	Siemens CT Project - Optimization of Injection Protocols
Gambhir, Sanjiv Sam	Baseline Study LLC	The Baseline Study, Verily Life Sciences
Gambhir, Sanjiv Sam	Biogen MA, Inc.	Develop and Evaluate Nuclear Imaging Reporter Genes (NI-RGs) for the CNS
Gambhir, Sanjiv Sam	Pliant Therapeutics, Inc	Detection of Integrin $\alpha v\beta 6$ in Pancreatic Cancer and Idiopathic Pulmonary Fibrosis with [^{18}F] FP-R01MG-F2: A First-in-Human Study
Gambhir, Sanjiv Sam	Sanofi-Aventis	Cu-DOTA-B-Fab as a PET Tracer for Evaluating CA6 Expression in Tumors: a First in Human Study
Ghanouni, Pejman	InSightec	A Continued Access Study to Evaluate the Effectiveness and Safety of ExAblate Transcranial MRgFUS Thalamotomy Treatment of Medication Refractory Essential Tremor Subjects
Ghanouni, Pejman	InSightec	A Feasibility Clinical Trial of the Management of the Medically-Refractory Dyskinesia Symptoms of Advanced Idiopathic Parkinson's Disease with Unilateral Lesioning of the Globus Pallidum Using the Exablate Transcranial System
Ghanouni, Pejman	InSightec	A Phase IV Post Approval Clinical Study of ExAblate Treatment of Metastatic Bone Tumors for the Palliation of Pain
Ghanouni, Pejman	InSightec	A Post Approval Registry: ExAblate Treatment of Metastatic Bone Tumors for the Palliation of Pain
Ghanouni, Pejman	InSightec	Post-ExAblate Pregnancy Outcomes Study: ExAblate Tratement of Symptomatic Uterine Fibroids
Gold, Garry	GE Healthcare	PET-MRI Advanced Research and Development Project
Gold, Garry	Siemens Medical Solutions USA, Inc.	Combined Investigations: zeego flexibility and image quality improvement Phase II
Hargreaves, Brian	GE Medical Systems	Advanced MR Applications Development - Tiger Team Years 9 & 10
Iagaru, Andrei	GE Healthcare	Advanced Research for Digital PET-CT

Iagaru, Andrei	GE Healthcare	External Validation of the Next Generation PET-CT System
Iagaru, Andrei	Piramal Imaging SA	[^{68}Ga]RM2 ([^{68}Ga]-Bombesin) PET-MRI Imaging of Patients with Biochemically Relapsed Prostate Cancer and Equivocal Conventional Imaging Findings
Kothary, Nishita	EchoPixel, Inc.	3D Virtual Reality for Endovascular Procedures
Kothary, Nishita	Siemens Medical Solutions USA, Inc.	Combined Investigations: zeego Flexibility and Image Quality Improvement
Kothary, Nishita	SillaJen Biotherapeutics, Inc.	A Phase 3 Randomized, Open-Label Study Comparing Pexa-Vec (Vaccinia GM-CSF / Thymidine Kinase-Deactivated Virus) Followed by Sorafenib Versus Sorafenib in Patients with Advanced Hepatocellular Carcinoma (HCC) without Prior Systemic Therapy
Larson, David	Siemens Corporate Research	Siemens QI Project-The Patient-Centric Benefits of "Connectedness" Between Imaging Modalities and the Imaging Informatics Enterprise Aka SYNGO Teamplay Research Investigation
Leung, Ann	Genentech, Inc.	Mobile Lung Cancer Screening Care for the Underserved
Levin, Craig	Ziteo Medical, Inc.	A Hand-Held PET Imaging Camera for Intra-Operative Use
Mallick, Parag	GE Healthcare	Integration of Multi-Modal PET-MR Imaging with Multi-Omic Analysis for Prediction of Patient Outcomes in Lung Cancer
Marks, Michael	MicroVention, Inc.	HDE Application for Low-Profile Visualized Intraluminal Support Device (LVIS and LVIS Jr.)
Napel, Sandy	Kitware, Inc.	Accelerating Community-Driven Medical Innovation with VTK
Pelc, Norbert	GE Healthcare	Advanced Computed Tomography (CT) Systems and Algorithms
Pelc, Norbert	Philips Healthcare	Spectral CT
Pelc, Norbert	Siemens Corporate Research	XMR detector
Plevritis, Sylvia	Grail Bio	Lung Cancer Screening Simulation
Rubin, Daniel	Genentech, Inc.	Advanced Retinal Image Analysis of HARBOR Data
Rubin, Daniel	Leidos Biomedical Research, Inc.	AIM-DICOM SR Harmonization Project
Rubin, Daniel	Sage Bionetworks	Digital Mammography DREAM Challenge
Rutt, Brian	GE Healthcare	Development of Novel Compact UHF MRI Concepts
Soh, H. Tom	Merck Sharp & Dohme Corp.	Evaluation of Differential Protein Expression in Jurkat T Cell Model of HIV Latency
Sze, Daniel Yung-Ho	Biocompatibles UK Ltd	A TheraSphere® Advanced Dosimetry Retrospective Global Study Evaluation in Hepatocellular Carcinoma Treatment
Sze, Daniel Yung-Ho	W. L. Gore & Associates, Inc.	An Evaluation of the GORE Conformable TAG Thoracic Endoprosthesis for the Primary Treatment of Aneurysm of the Descending Thoracic Aorta
Thakor, Avnesh	GE Healthcare	Targeting Mesenchymal Stem Cells to the Pancreas Using Pulsed Focused Ultrasound: a Novel Application to Treat Diabetes
Thakor, Avnesh	SEKRIS Biomedical, Inc.	Improving Pancreatic Islet Transplantation with DNA Immunotherapy
Vasanawala, Shreyas	GE Medical Systems	Wireless Receiver Coil Transponders for MRI
Willmann, Juergen	Bracco Diagnostic, Inc.	Monitoring Inflammation by Real-Rime Fused MRI/Molecular US Imaging in Porcine Acute Terminal Ileitis
Willmann, Juergen	Bracco Diagnostic, Inc.	Treatment Monitoring in Transgenic Mouse Model of Inflammatory Bowel Disease using Dual-Selectin-Targeted Contrast-Enhanced Ultrasound Imaging
Willmann, Juergen	EpicentRx, Inc.	3D DCE-US for Characterization of RRx-001 Effects
Willmann, Juergen	GE Healthcare	Development and Testing of a New Passive Cavitation Detection Algorithm for Ultrasound-Guided Therapeutic miRNA Modulation in Hepatocellular Carcinoma
Willmann, Juergen	NuvOx Pharma LLC	B7-H3-Targeted Contrast Agent for Ultrasonic Detection of Breast Cancer
Willmann, Juergen	NuvOx Pharma LLC	Pancreatic Ductal Adenocarcinoma Targeted Ultrasound Contrast Agent Development
Willmann, Juergen	Philips Healthcare	Correlating Liver Stiffness Measurements from Ultrasound Shear Wave Imaging To Magnetic Resonance Elastography
Willmann, Juergen	Siemens Medical Solutions USA, Inc.	Introduction of Ultrasound Contrast Imaging and Quantitative Elastography into Clinic
Wintermark, Max	Silk Road Medical	Comparing DW-MRI Imaging Studies Before and After Treatment for Carotid Atherosclerotic Disease
Zaharchuk, Greg	GE Healthcare	Technical MRI Improvements in Rapid Imaging with MR Fingerprinting

FOUNDATION AND PROFESSIONAL SOCIETY AWARDS

Airan, Raag	The Dana Foundation	Towards Clinical Translation of Noninvasive Neuromodulation via Focused Ultrasonic Drug Uncaging
Airan, Raag	Foundation of the American Society of Neuroradiology	Wada 2.0: Focal Delivery of Anesthetics to the Brain via Noninvasive Focused Ultrasound
Butts Pauly, Kim	Focused Ultrasound Surgery Foundation	Acoustic Parameters of Bone as a Function of HU and MRI
Butts Pauly, Kim	Focused Ultrasound Surgery Foundation	Neuro Focused Ultrasound MR Coil Fabrication and Testing
Daldrup-Link, Heike	The Musculoskeletal Transplant Foundation	Imaging Immune Responses to Stem Cell Mediated Bone Repair
Eifler, Aaron	Society for Interventional Radiology Foundation	Determining the Threshold for Intervention in May-Thurner Syndrome: an Imaging Informatics Approach
Gambhir, Sanjiv Sam	The Ben and Catherine Ivy Foundation	A New Strategy to Image Tumor Metabolism in GBM Patients to Help Optimize Anti-Tumor Therapies
Gambhir, Sanjiv Sam	The Ben and Catherine Ivy Foundation	Glioma Imaging
Gambhir, Sanjiv Sam	The Ben and Catherine Ivy Foundation	Next Generation Neuro-Oncological Imaging Strategies

Ghanouni, Pejman	Focused Ultrasound Surgery Foundation	Lumbar Back Pain
Going, Catherine	American Society for Mass Spectrometry	ASMS Postdoctoral Award
Guo, Haiwei Henry	Society of Thoracic Radiology	Assurance of Subsolid Pulmonary Nodule Visualization by Low-Dose CT, Facilitated by 3-D Printing
Heit, Jeremy	RSNA	Resting State Spontaneous Fluctuations of the BOLD Signal for Penumbra Assessment in Endovascular Stroke Candidates
Iv, Michael	RSNA	Using Ferumoxytol-Enhanced MRI to Assess Tumor-Associated Macrophages in Human Glioblastoma Multiforme
Kesselman, Andrew	Society for Interventional Radiology Foundation	Endovascular Removal of Fractured IVC Filter Fragments: A 5-year Prospective Study
Larson, David	Intermountain Healthcare	Intermountain - Stanford Grant Program
Lungren, Matthew	GERRAF	Machine Learning Classification of Radiology Reports to Develop and Evaluate a Clinical Decision Support Intervention that Optimizes Imaging Utilization
McNab, Jennifer	The Dana Foundation	Localization of Deep Brain Stimulation Targets Using Diffusion MRI Fiber Tracking Validated Against CLARITY 3D Histology
Parivash, Sherveen	RSNA	Characterizing the Radiologic Abnormalities Observed in Chronic Fatigue Syndrome and Assessing the Potential Use of Advanced MRI in Clinical Diagnosis
Patel, Chirag	American Brain Tumor Association	Hypoxia Inducible Factor-1alpha and Sirtuin Inhibition in Glioblastoma in Conjunction with Tumor Treating Fields
Rubin, Daniel	ECOG ACRIN Medical Research Foundation	ECOG-ACRIN Network Group Operations Center
Rubin, Daniel	RSNA	Medical Image Sharing Through a Patient-Controlled Exchange System
Rubin, Daniel	RSNA	Unification of LOINC Radiology and the RadLex Playbook
Sagreiya, Hersh	RSNA	Quantitative Analysis of Ovarian Cancer with Novel Molecular Ultrasound Agent BRR
Smith, Bryan	American Association for Cancer Research	Treatment Enhancement by Specific Manipulation of Tumor Immunosuppression
Stoyanova, Tanya	Prostate Cancer Foundation	Proteolytically Cleaved Receptors as Oncogenes and Therapeutic Targets in Advanced Castration Resistant Prostate Cancer
Willmann, Juergen	Focused Ultrasound Surgery Foundation	A Novel Genetic Reprogramming Therapy for Hepatocellular Carcinoma Using Focused Ultrasound-Guided Delivery of microRNA
Yeom, Kristen	Foundation of the American Society of Neuroradiology	Radiogenomic Approaches to Non-Invasive Molecular Subtyping of Pediatric Posterior Fossa Ependymomas
Zeineh, Michael	Doris Duke Charitable Foundation	The Role of Iron and Inflammation in Alzheimer's Disease: from *Ex Vivo* to *In Vivo*
Zeineh, Michael	The Dana Foundation	The Role of Iron in Alzheimer's Disease

STANFORD INTERNAL AND OTHER FUNDING

Airan, Raag	Coulter Endowment Program	Towards Clinical Translation of Noninvasive Neuromodulation via Focused Ultrasonic Drug Uncaging
Chin, Frederick	Bio-X	A Novel "Trigger and Release" Chemical Strategy for Imaging Tumor Hypoxia *In Vivo*
Dahl, Jeremy	Coulter Endowment Program	A Universal Peripheral Enabling 3D Structural & Flow Imaging on Any Ultrasound System: Applications in Vascular Screening and Beyond
Daniel, Bruce	Bio-X	Technologies for Mixed-Reality Breast Surgery
Rubin, Daniel	Bio-X	A Machine Learning Approach to Automated Detection and Characterization of Dendritic Spines in the Mammalian Brain
Spielman, Daniel	Bio-X	*In Vivo* Metabolic Imaging of Senescent Cells Using Hyperpolarized ^{13}C MRS

Funded Projects Summary

$26M
NIH
80 awards

$21M
Industry
59 awards

$3.0M
Non-Profit
30 awards

$2.5M
Other Government
11 awards

$2.4M
NIH Subcontracts
36 awards

$0.3M
Stanford Internal
6 awards

Radiology Snapshot

203
Radiology Faculty
All Inclusive

Top **10**
Residency Training
US News & World Report 2015–17

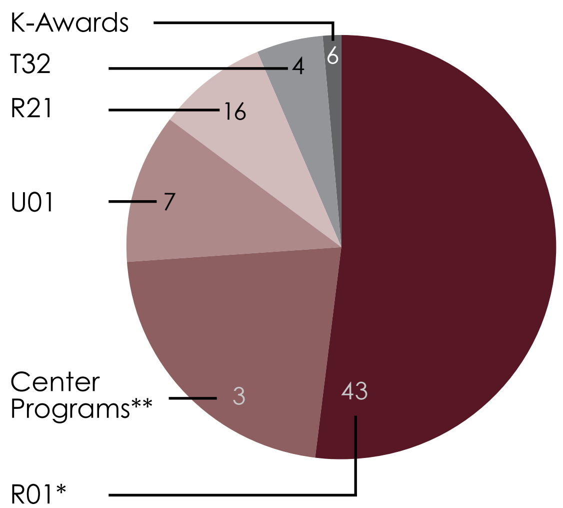
#2
NIH Rank
according to Academy of Radiology Research, acadrad.org, FY15

250
Radiology Trainees
(Fellows, Residents, Postdocs, Students, Visitors)

205
Sponsored Projects
Total Number of Active Sponsored Projects FY17

6
Distinguished Investigators
Academy of Radiology Research, acadrad.org, 2016–17

NIH Award Types

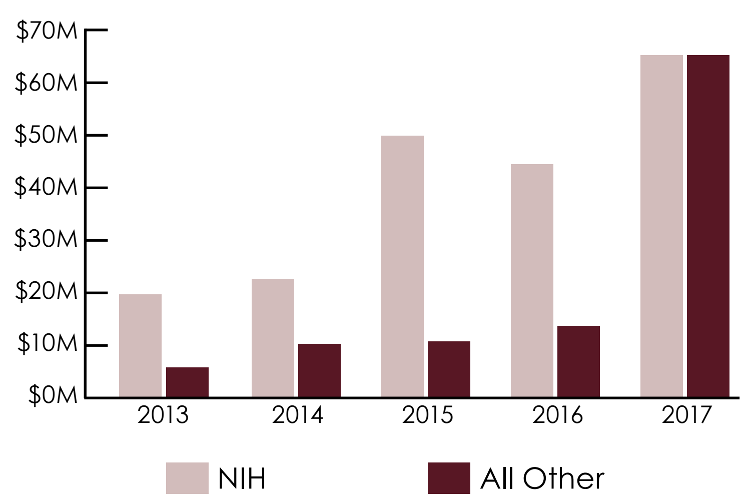


*R01 includes R00, K24, RF1

**Center includes P41 and U54s

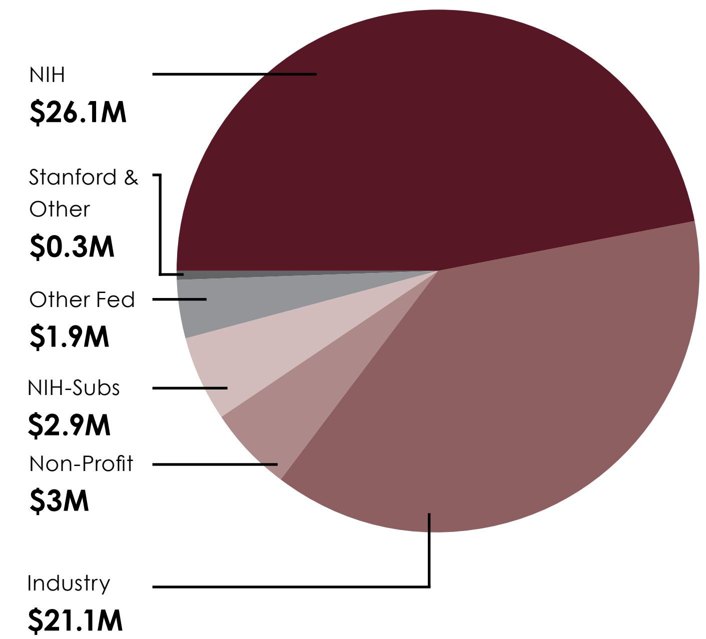
New Awards (FY 2013–2017)

Total new dollars/year—all years of award



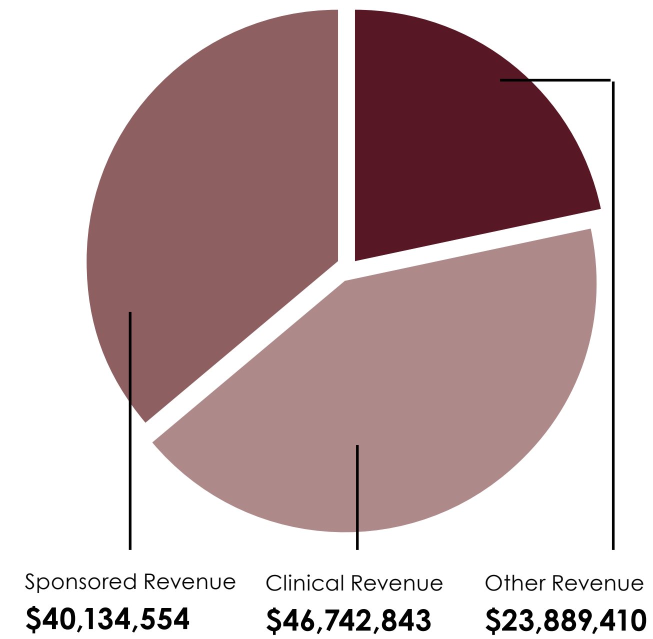
Research Funding FY17

$55,363,639 (total dollars)

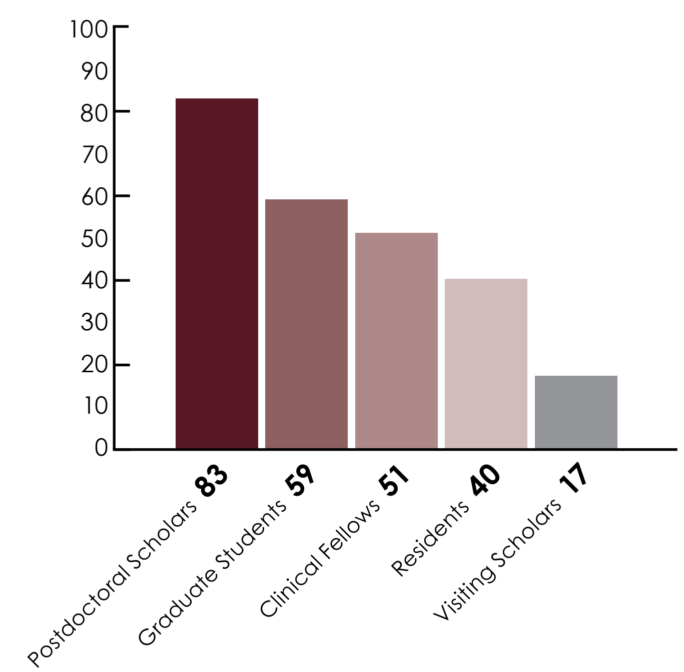


Budgeted Revenue FY17

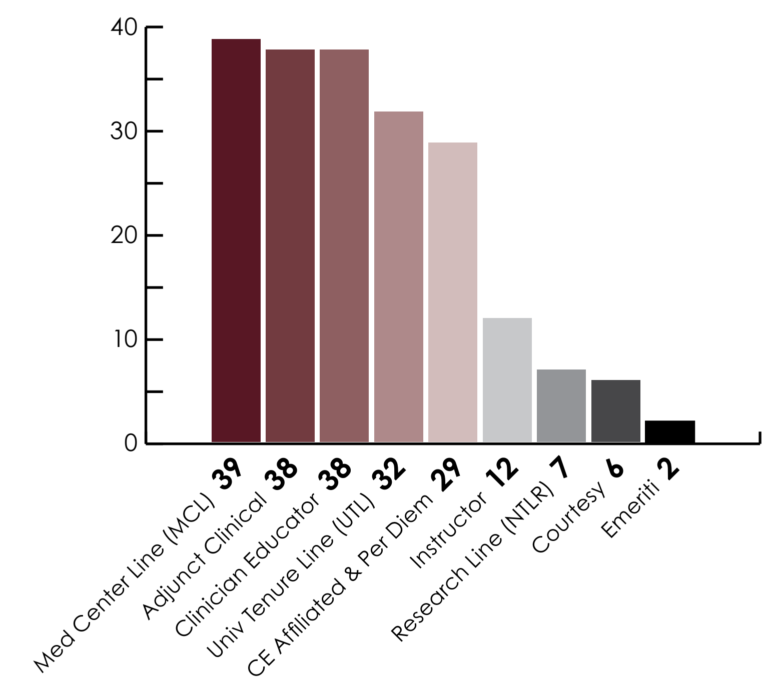
$110,766,807



Trainees: 250



Faculty: 203



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We appreciate the dedication of staff, including nurses, technologists, informatics teams, coordinators, and administration who help make our department as successful as it is today.

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2016 RSNA Reception


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2017 Faculty Photo


2017 Radiology Department Photo

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The Canary Challenge is an annual cycling event and 5K walk/run that increases awareness and raises funds for the Canary Center at Stanford for Cancer Early Detection. Each year in September, an amazing community of cyclists, volunteers, and sponsors come together to take part in one of Northern California's premier fundraising events. Together, they have raised millions of dollars to support research programs that are improving cancer detection and survivorship. In 2017 alone, more than 800 participants raised nearly $735,000. Established in 2011, the Canary Challenge is organized by the Canary Foundation, the world's first non-profit organization dedicated solely to the funding, discovery, and development of tests for early detection of cancer. Learn more about the Canary Challenge at www.canarychallenge.org.

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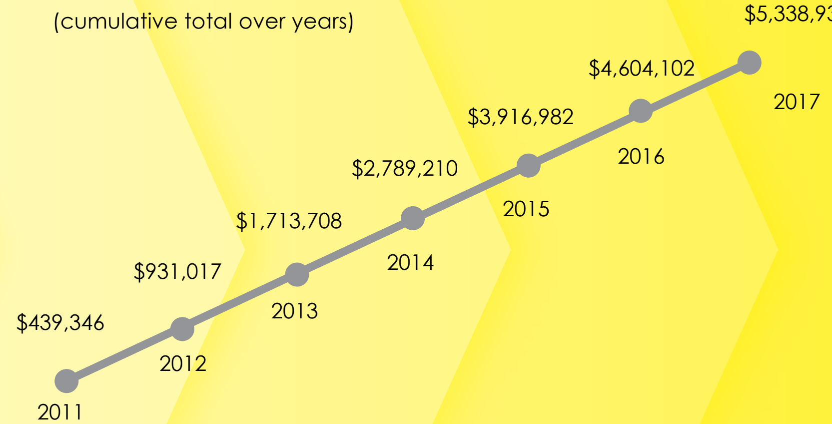

www.canarychallenge.org

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