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.
From the Chairman

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 (AlphaLab), 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 MRI, 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 + photoacoustic). (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 acquired 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.

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 spectrometry 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, Pissani, and Haber 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 positio
in Nuclear Medicine: a nuclear medicine/molecular imaging physician scientist and a targeted radionuclide therapy expert; (3) One position in IBIS (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 Spillner 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—billions of dollars in new funding, new career opportunities, and new leadership in the field of radiology—increases our passion to continue to build bridges with the local community and the annual Canary Challenge Bike Ride, one true example of our success in community engagement. This annual event, established in 2011, has been highly successful with more than 800 riders who collectively raised $735,000 for cancer research and prevention at the Canary Challenge on September 30, 2017. We look forward to continuing this initiative and partnership with the Canary Foundation for many years to come.

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

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—much of Dr. Sommer’s research focused on 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

Helke 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 Dalsen, 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

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

Max Wintermark, MD, MBA
Division Chief, Neuroimaging & Neurointervention
Radiology Faculty

Body Imaging
Quazi Al-Tariq, MD
Adjunct Clinical Instructor
John Chang, MD, PhD
Adjunct Clinical Instructor
Lawrence Chow, MD
Clinical Associate Professor
Bruce Daniel, MD
Professor
Terry Dessar, MD
Professor
Ahmed El Kaffas, PhD
Instructor
Michael Federle, MD
Professor
Stuart Stein, MD
Adjunct Clinical Assistant Professor
Russell Stewart, MD, MBA
Clinical Assistant Professor
Valney Van Doorem, MD
Clinical Professor
Scott Williams, MD
Adjunct Clinical Assistant Professor
Juergen Wilkman, MD
Professor
Michael Yang, MD
Adjunct Clinical Instructor
Breast Imaging
Audra Brunelle, MD
Clinical Assistant Professor
Wendy DeMartini, MD
Professor
Debra Reda, MD
Professor
Kristina Jung, MD
Adjunct Clinical Instructor
Jeff Lipson, MD
Clinical Instructor
Sunita Pal, MD
Clinical Associate Professor
Lisa Schmelzel, MD
Clinical Assistant Professor
Xin Ye, MD
Clinical Instructor
Body MRI
Pajimn Ghanouni, MD, PhD
Assistant Professor
Robert Herfkens, MD
Professor
Douglas Lake, MD
Adjunct Clinical Assistant Professor
Andreas Leening, MD, PhD
Assistant Professor
Michael Muelly, MD
Clinical Instructor
Sheyab Vasavada, MD, PhD
Associate Professor

Canary Center at Stanford for Cancer Early Detection
Utkarsh Demirci, PhD
Professor
Sanjiv Sam Gambhir, MD, PhD
Professor
Don Letwin, BEng
Adjunct Professor
Panag Matlick, PhD
Assistant Professor
Viswan Narir, MD
Clinical Assistant Professor
Sharon Pittier, PhD
Clinical Assistant Professor
Johannes Ritter, PhD
Instructor
H. Tom Soh, PhD
Professor
Tonya Stoyanova, PhD
Assistant Professor

Cardiovascular Imaging
Christoph Becker, MD
Professor
Frankidis 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

Interventional Radiology
Richard Baxter, MD
Adjunct Clinical Associate Professor
Lawrence [Rusty] Hofmann MD
Professor
Richard Hong, MD
Adjunct Clinical Instructor
David Housepian, MD
Clinical Professor
Gloria Hwang, MD
Clinical Associate Professor
Ibrahim Idakoji, MD
Clinical Instructor
Andrew Kesselman, MD
Clinical Instructor
Nikhita Kothary, MBBS
Associate Professor
William Kuo, MD
Associate Professor
John Loule, MD
Clinical Associate Professor
Charles P. Semba, MD
Adjunct Professor
Talay Shizumi, MD
Clinical Assistant Professor
Daniel Sae, MD, PhD
Professor
Linda Tang, MD
Adjunct Clinical Assistant Professor
David Wang, MD
Clinical Assistant Professor

Molecular Imaging Radology (MIPS)
Vikram Bajpai, PhD
Adjunct Professor
Carlynn Bartazzi, PhD
Professor
Joshua Cafes, PhD
Instructor
Zhen Cheng, PhD
Associate Professor
Frederick Chin, PhD
Associate Professor
Sanjiv Sam Gambhir, MD, PhD
Professor
Edward Graves, PhD
Associate Professor
Stefan Harmsen, PhD
Instructor
Sharen Hori, PhD
Instructor
Michael James, PhD
Assistant Professor
Jeff Kleeck, PhD
Adjunct Professor
Shivani Kummur, 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
*D Courtesy Appointment

Integrative Biomedical Imaging Informatics (IBIIS)
Benedict Anchang, PhD
Instructor
Curtis Langlotz, MD, PhD
Professor
Sandy Naepl, PhD
Professor
David Park, PhD
Adjunct Lecturer
Sylvia Plevan, PhD
Professor
Daniel Rubin, MD, MS
Associate Professor

Radiology Department Report 2015–2017
Neuroimaging and Neurointervention

Christopher Neal, MD
Adjunct Clinical Assistant Professor

Rajiv Pandit, MBBS
Assistant Professor

Rajkumar Pandey, MD
Clinical Assistant Professor (Affiliated)

Mrudula Pentar, MD
Clinical Instructor

Nelvi Thakur, MD
Adjunct Clinical Instructor

Vikas Vij, MD
Adjunct Clinical Assistant Professor

Max Wintermark, MD, MBA
Professor

Kristen Yeom, MD
Associate Professor

Huy Do, MD
Professor

Micrea Dobré, MD
Adjunct Clinical Instructor

Robert Dodd, MD, PhD
Assistant Professor

David Douglas, MD
Adjunct Clinical Professor

Nancy Fischbein, MD
Professor

Ethan Foxman, MD
Adjunct Clinical Assistant Professor

Bo Yoon Ha, MD
Clinical Assistant Professor (Affiliated)

Syed Haishm, MD
Clinical Instructor

Jeremy Heit, MD, PhD
Clinical Assistant Professor

Michael Iv, MD
Clinical Assistant Professor

John Jordan, MD
Adjunct Clinical Professor

Srijata Komakula, MBBS
Adjunct Clinical Assistant Professor

Bryan Loneman, MD
Clinical Instructor

Conway Lien, MD
Adjunct Clinical Instructor

Michael Marks, MD
Professor

Tarik Massoud, MD, PhD
Professor

Lex Mitchell, MD
Adjunct Clinical Instructor

Joseph Cheng, PhD
Instructor

Jeremy Dal, PhD
Assistant Professor

Hisham Dahmoush, MBCh
Clinical Instructor

Helke Daldup-Link, MD
Professor

Satwan Halabi, MD
Clinical Assistant Professor

Diana Jaramillo, MD
Adjunct Clinical Assistant Professor

Robert Jones, MD
Adjunct Clinical Instructor

Ralph Lachman, MD
Clinical Professor

Fred Lanningham, MD
Clinical Assistant Professor

David B. Larson, MD
Associate Professor

Edward Lebowitz, MD
Clinical Professor

Matthew Lungren, MD
Assistant Professor

Beverly Newman, MBCh
Professor

Alex Ostrovsky, MD, PhD
Adjunct Lecturer

Erika Rubesova, MD
Clinical Associate Professor

Matthew Schmitz, MD
Adjunct Clinical Instructor

Jayne Seekins, DO
Clinical Assistant Professor

Glenn Seidel, MD
Clinical Professor

Avnish Thakor, MD, PhD
Assistant Professor

Shreyas Vasanawala, MD, PhD
Associate Professor

Kristen Yeom, MD
Associate Professor

Evan Zucker, MD
Clinical Assistant Professor

* Courtesy Appointment

Radiological Sciences Laboratory (RSL)

Audrey Fan, PhD
Instructor

Gary Glover, PhD
Professor

Brian Hargreaves, PhD
Associate Professor

Felix Kogan, PhD
Instructor

Marc Levenston, PhD
Associate Professor

Jennifer McNab, PhD
Assistant Professor

Michael Moseley, PhD
Professor

Kim Butts Pauly, PhD
Professor

Norbert Pelc, SC0
Professor

Allan Reiss, MD
Professor

Brian Rutt, PhD
Professor

Daniel Spielman, PhD
Professor

Thoracic Imaging

Henry Gao, MD, PhD
Clinical Assistant Professor

Ann Leung, MD
Professor

Margaret Lin, MD
Adjunct Clinical Assistant Professor

Emily Tasi, MD
Clinical Instructor

VA Radiology

Stephanie Chang, MD
Clinical Instructor (Affiliated)

Bao Do, MD
Clinical Assistant Professor (Affiliated)

Christine Ghanian, 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

Beverly Newman, MBBCh
Assistant Professor

Michael Marks, MD
Adjunct Clinical Instructor

Charu Vasanawala, MBBS
Clinical Assistant Professor

* Courtesy Appointment

VA Nuclear Medicine

Christine Keeling, MBBS
Clinical Assistant Professor (Affiliated)

George Segal, MD
Professor

Minal Vasanawala, MBBS
Clinical Assistant Professor (Affiliated)
New Faculty Appointments (2016–2017)

Raag Airan, MD, PhD
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 (2012). 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
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
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
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. Jordonov Radiation Instrumentation Award in 2014, 2015, and 2016.

Joseph Cheng, PhD
Dr. Cheng received his BS degree at MIT (2004) 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.

Hisham Dahmoush, MBBCh
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 (2002–2013). 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 neuroradiology fellowship (2015) and a one-year interventional radiology residency at the Brigham and Women’s Hospital in Boston before joining our department in 2016.

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.

Lawrence Chow, MD
Clinical Associate Professor
Body Imaging

Guido Davidzon, MD
Clinical Assistant Professor
Nuclear Medicine

Dr. Davidzon earned his MD degree from Universidad Mamónides in Buenos Aires, Argentina (2003) and completed a two-year neurology research fellowship at Columbia University (2004), 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 Stanford University before joining our department in 2017.

Clinical Instructor (Affiliated)
Body MRI

Clinical Instructor
Pediatric Radiology

Clinical Instructor
Neuroimaging

Clinical Instructor (Affiliated)
Molecular Imaging Program of Stanford (MIPS)

Instructor
Pediatric Radiology

Instructor Integrative Biomedical Imaging Informatics (IBIIS)

Instructor
Neuroimaging

Assistant Professor
Neuroimaging

Assistant Professor
Clinical Assistant Professor
Radiology Department Report 2015–2017
New Faculty Appointments (2016–2017)

Joseph DeMartini, MD
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 of the University of Wisconsin-Madison (2013–2016) prior to joining our department as a Clinical Associate Professor in 2016.

Ahmed El Kaffas, PhD
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
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 Asstant Professor at the University of Colorado Denver. She joined our department as a Clinical Instructor in 2017.

Sharon Hori, PhD
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
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

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.

Shivaani Kummar, MD

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

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.

Feliks Kogan, PhD

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 post-doctoral fellowship in the Radiological Sciences Lab (RSL) (2015), and continued on as a Research Associate (2015–2017). He was named an ISMRM Junior Fellow (2018), 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.

Edward Lo, MD

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 (2013). 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.

Sachin Malik, MD

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

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.

Ying Lu, PhD

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.
Michael Muelly, MD

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

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 (Eramus 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

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

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

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

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.

Stephan Rogalla, MD

Dr. Rogalla received his MD (2006) from Humboldt University of Berlin, in Germany. 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

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

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 (2014). 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

Dr. Tsai received her MD from Stanford University (2011). She completed her radiology residency at UCLA (2016), followed by a thoracic imaging fellowship at NYU as Chief Fellow (2014). Dr. Tsai joined Stanford Radiology as a Clinical Instructor in thoracic imaging in 2017.

Katheryne Wilson, PhD

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

Dr. Ye received his MD from UCLA (2011). He completed a preliminary medicine internship at the White Memorial Medical Center (WMMAC) in Los Angeles (2012). He then completed radiology residencies at Emory University (2013) and Loma Linda University (2014) 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

Dr. Yohannan received his MD from the University of Illinois (2011) 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.

Quazi Al-Tariq, MD
Adjunct Clinical Instructor
Body Imaging

Jana Chaaloufi, MD
Adjunct Lecturer
Pediatric Radiology

Wilson Chwang, MD, PhD
Adjunct Clinical Instructor
Neuroimaging

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

David Douglas, MD
Adjunct Clinical Instructor
Neuroimaging

Sanjay Gupta, MD
Adjunct Clinical Instructor
Cardiovascular Imaging

Diego Jaramillo, MD
Adjunct Clinical Professor
Pediatric Radiology

Connie Montgomery, MD
Adjunct Clinical Instructor
Musculoskeletal Imaging

Alex Olminsky, 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

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

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 Kris 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 Alvin 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.
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 52in52 initiative is an accountable 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.

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 Arian, MD, PhD 2017 Finalist for the Science-PINS Prize for Neuromodulation
Joseph Cheng, PhD 2017 SMRM Magna Cum Laude Merit Award
Bruce Daniel, MD 2016 Elected to AIMBE College of Fellows
Guido Davidzon, MD 2017 SNMMI Emerging Leaders Award
Wendy DelMarini, MD 2017 Elected President of the Society of Breast Imaging
Utkan Demirci, PhD 2017 Elected to AIMBE College of Fellows
David Douglas, MD 2017 Ursula Mary Kocemba-Slosky, PhD, Professional Relations Fellowship
Rebecca Fahrig, PhD 2016 Elected to AIMBE College of Fellows
Sanji Som Gambhir, MD, PhD 2016 Elected to the National Academy of Inventors
Pejman Ghanouni, MD, PhD 2017 Honorary President of the 6th International Symposium on Focused Ultrasound
Gary 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 SMRM 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 Lungen, MD, MPH 2017 Best Poster at The Coalition for Imaging and Bioengineering Research (CIBR)
I. Ross McDougall, MD, MPH 2017 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-Tortulka Fellowship
Norbert Pelc, ScD 2016 Awarded Honorary Degree by Freie-Alexander-Universitat Erlangen-Nurnberg (FAU)
George Segall, MD, MS 2017 Elected for National Cancer Institute Board of Scientific Advisors
H. Tom Soh, PhD 2017 Named Chan Zuckerman Bi hub Senior Investigator
Tanya Stoyanova, PhD 2016 McCormick-Gabiann Faculty Award
Sheyas Vasanawala, MD, PhD 2016 Academy of Radiology Research Distinguished Investigator Award
Juergen Willmann, MD 2017 Elected to AIMBE College of Fellows
Joseph Wu, MD, PhD 2017 American Heart Association Merit Award
Greg Zaborzuck, MD, PhD 2016 Academy of Radiology Research Distinguished Investigator Award
Future Faculty and Staff
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

<table>
<thead>
<tr>
<th>Location</th>
<th>Equipment</th>
<th>Opening</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cancer Center South Bay</td>
<td>CT, MRI, PET-CT, 2 Digital Breast Tomosynthesis, ultrasound, X-ray</td>
<td>July 2015</td>
</tr>
<tr>
<td>Children’s Hospital Expansion</td>
<td>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)</td>
<td>December 2017</td>
</tr>
<tr>
<td>Emeryville</td>
<td>MRI, CT, SPECT-CT, Digital Breast Tomosynthesis, X-ray, ultrasound, BMQ, Angiography-Hybrid</td>
<td>March 2017</td>
</tr>
<tr>
<td>New Stanford Hospital</td>
<td>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</td>
<td>2019</td>
</tr>
<tr>
<td>Redwood City - Pavilion D Expansion</td>
<td>CT, ultrasound, X-ray, EOS</td>
<td>Spring 2018</td>
</tr>
<tr>
<td>Stanford Neurosciences Center</td>
<td>CT, MRI, PET-MR, ultrasound, X-ray/Fluoro</td>
<td>December 2015</td>
</tr>
<tr>
<td>Valley Care Medical Center</td>
<td>MRI, GI Fluoro, and Digital Breast Tomosynthesis equipment replacements in progress</td>
<td>April 2015</td>
</tr>
<tr>
<td>Valley Care Medical Center</td>
<td>MRI, GI Fluoro, and Digital Breast Tomosynthesis equipment replacements in progress</td>
<td>April 2015</td>
</tr>
</tbody>
</table>

### New/Upgraded Equipment in Stanford Hospital

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

### New/Upgraded Research Equipment

<table>
<thead>
<tr>
<th>Location</th>
<th>Equipment</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Clark Center SCP</td>
<td>7T MRI small animal system upgrade</td>
<td></td>
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<tr>
<td></td>
<td>microCT replacement</td>
<td></td>
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<tr>
<td>Canary Center</td>
<td>Magnetic Particle Imaging Instrument</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Data Servers, H-Speed Centrifuges, Gas Chromatograph, Microscope(s), Fluorescence Imaging Systems</td>
<td></td>
</tr>
<tr>
<td>Lucas Center</td>
<td>MRI hardware and software upgrade with high-end gradients and new technology</td>
<td></td>
</tr>
<tr>
<td></td>
<td>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</td>
<td></td>
</tr>
</tbody>
</table>
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 (SCI3). 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.

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 18F-, 11C-, 15N-, and 15O-isotopes as needed for each day’s radiochemistry schedule. In addition, the CRF can provide other radiometals (e.g., 68Ga, 64Cu, and 89Zr) 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 18F-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.
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

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 it 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.

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 (MBKDR) 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 MBKDR 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.

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

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 to 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, 18F-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.

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 exacerbating 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, “18F-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 unbelievably 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.
Fluorescence Imaging for Visual Guidance in Cancer Surgery

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 toxicity studies that permitted successful first-in-human clinical trials using near-infrared (NIR) labeled antibodies for surgical and 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.

Fluorescence Imaging during surgery is 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 100 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.

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.

Intraoperative fluorescence image with associated data following panitumumab-IRDye800CITM infusion. A high-dose contrast enhancement glioblastoma patient pre-resection imaging demonstrates the detection of residual tumor within the operating room.
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 Zaharchuk, MD, PhD, a radiologist; 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.
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.
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.

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; 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 (CIV) 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, catheter-directed thrombolysis, IVC filtration, venous reconstruction, vascular stenting, fibrinolysis, embolization, vascular anomaly ablation, pediatric interventions, TIPS, and aortic stenting. The Interventional Radiology service is an integral component of the Vascular Center at Stanford.

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 hepatocellular interventions, angioplasty, catheter-directed thrombolysis, IVC filtration, venous reconstruction, vascular stenting, fibrinolysis, embolization, vascular anomaly ablation, pediatric interventions, TIPS, and aortic stenting. 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.

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.

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.


**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 diagnostic, radiation therapy, and basic science. Since recruitment began in 2010, the program has supported and trained 20 graduate students.

**CURRENT TRAINEES**

- Dylan Black
- Ehsan Dadgar-Kiani
- Phillip DiGiacamo
- Ningyu Li
- Elise Robinson
- Christopher Sandino

**MENTORS**

- Olav Solgaard, PhD
- Jin Hyung Lee, PhD
- Michael Zehetmayer, MD, PhD
- Kim Butts Pauly, PhD
- Sanjiv Sam Gambhir, MD, PhD
- Shreyas Vasavada, MD, PhD

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**CSBS Program**

**Cancer Systems Biology Scholars Program**

NIH/NCI 5 R25 CA180993 03

PI: Sylvia Plevritis, PhD and Gary Nolan, PhD

Program Manager: Theresa McGinn

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**

- Gina Bouchard, PhD
- Roozbeh Dehghannasiri, PhD
- Aaron Horning, PhD
- Barzin Nabet, PhD

**MENTORS**

- Sylvia Plevritis, PhD and Arnato Giaccia, PhD
- Julia Salmon, PhD and Steven Arndt, MD, PhD
- Michael Snyder, PhD and Christina Curtis, PhD
- Edgar Engleman, MD, PhD and Sylvia Plevritis, PhD
- Max Dieth, MD, PhD, Andrew Gentles, PhD, and Rob Tibshirani, 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.

CURRENT TRAINEES
Timothy Blake, PhD
Viola Chen, MD
Ryan Davis, PhD
Arvin Gouw, PhD
Ashwin Ram, MD
Travis Shaffer, PhD

MENTORS
Robert Waymouth, PhD and Paul Wender, PhD
Alice Fan, MD and Shan Wang, PhD
Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD
Dean Felsher, MD, PhD and Richard Zare, PhD
Michael Snyder, PhD
Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD

Cancer-TNT Program
Cancer-Translational Nanotechnology Training Program
NIH/NCI 5 T32 CA196585 02
PIs: 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, nanoelectronics, and clinical medicine to advance cancer nanotechnology translation research, diagnosis, and treatment.

CURRENT TRAINEES
Timothy Blake, PhD
Viola Chen, MD
Ryan Davis, PhD
Arvin Gouw, PhD
Ashwin Ram, MD
Travis Shaffer, PhD

MENTORS
Robert Waymouth, PhD and Paul Wender, PhD
Alice Fan, MD and Shan Wang, PhD
Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD
Dean Felsher, MD, PhD and Richard Zare, PhD
Michael Snyder, PhD
Sanjiv Sam Gambhir, MD, PhD and Jianghong Rao, PhD

ARTS Program
Advanced Residency Training at Stanford Program
PIs: 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
Stephen Chang, MD
Asli Edlinwickrema, MD
Deshka Foster, MD
Geoff Kramplitz, MD
David Kurtz, MD
Eugene Richardson, MD
Makeda Robinson, MD

MENTORS
Mark Krasnow, PhD
Ravi Majeti, MD, PhD
Michael Longaker, MD
Irving Weissman, MD
Sanjiv Sam Gambhir, MD, PhD
Andrew Zolopa, MD
Shari Binov, MD
Graduating PhDs 2015–16

Matthew Bieniosek, 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

Sebastian Echegaray, PhD
Molecular Imaging Program at Stanford
Current Position:
Postdoctoral Scholar, Department of Radiology/IBIIS, Stanford University School of Medicine, Stanford, CA
Dissertation:
Electronic Readout Strategies for Silicon Photomultiplier-based Positron Emission Tomography Detectors

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:
Research Fellow, Massachusetts General Hospital, Boston, MA
Dissertation:
Model-Based Artifact Correction in MRI

Bragi Sveinsson, PhD
Radiological Sciences Laboratory
Current Position:
Apple, Mountain View, CA
Dissertation:
Quantitative Measurements and Artifact Correction Methods in Body Magnetic Resonance Imaging
Graduating PhDs 2016–17

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

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

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: 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

Umit Yoruk, PhD
Radiological Sciences Laboratory
Current Position: Senior Software Engineer, Oracle, San Bruno, CA
Dissertation: Quantification of Glomerular Filtration Rate using DCE-MRI in Children

Uchechukwuka Monu, PhD
Radiological Sciences Laboratory
Current Position: Senior Software Engineer, Magic Leap, Plantation, FL
Dissertation: Data Sampling and Constrained Reconstruction for High-Dimensional MRI
### Trainee Honors and Awards

<table>
<thead>
<tr>
<th>Name</th>
<th>Year and Award Details</th>
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<tr>
<td>Daehyun Yoon, PhD</td>
<td>2016 ISMRM Magna Cum Laude Merit Award</td>
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<tr>
<td>Katherine Wilson, PhD</td>
<td>2017 Molecular Imaging Young Investigator Prize</td>
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<tr>
<td>Martin J. Willemink, MD</td>
<td>2016 European Radiology Most Cited Paper Award at the European Society of Radiology</td>
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<tr>
<td>Hans Weber, PhD</td>
<td>2017 ISMRM Junior Fellow</td>
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<tr>
<td>Ophir Vermesh, MD, PhD</td>
<td>2016 Best Talk Award at the SIRPA Postdoctoral Research Symposium</td>
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<tr>
<td>Anshul Hadipur, MD</td>
<td>2017 ISMRM Magna Cum Laude Merit Award</td>
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<tr>
<td>Jia Guo, PhD</td>
<td>2016 RSNA Trainee Research Prize Award</td>
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<tr>
<td>Kai Li, PhD</td>
<td>2016 Poster Award, World Molecular Imaging Congress (WMIC)</td>
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<tr>
<td>Feliks Kogan, PhD</td>
<td>2016 Young Investigator Cum Laude Award Winner</td>
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<tr>
<td>Kai Li, PhD</td>
<td>2016 Poster Award, World Molecular Imaging Congress (WMIC)</td>
</tr>
<tr>
<td>Wilson Lin, MD</td>
<td>2016 RSNA Trainee Research Prize Award</td>
</tr>
<tr>
<td>Michael Mazzanduono, PhD</td>
<td>2016 Poster Award, World Molecular Imaging Congress (WMIC)</td>
</tr>
<tr>
<td>Aaron Repasin, MD</td>
<td>2016 Invitation to the SIR Grassroots Leadership Program</td>
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<tr>
<td>Alexander Shiu, MD</td>
<td>2016 Stanford Society of Physician Scientists (SSPS) Grant</td>
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<tr>
<td>Subashri Shinivasan, PhD</td>
<td>2016 ISMRM Junior Fellow</td>
</tr>
<tr>
<td>Riccardo Stora, PhD</td>
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### 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 Nagel (Scientific Director), Dr. Dominik Fleischmann (Clinical Director), Dr. Roland Bammer (Technical Director), and Mr. Shannon Walters (Executive Manager).

**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.

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### 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: Sparing 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 3D imaging.
Clinical Divisions

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.

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.
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 Best Interventional Study Group Presentation Award; Dr. Daniel: 2017 ISMRM 2nd place Paper award; Dr. Willmann: 2016 SAR Best Translational Science Paper award.

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 diagnostics 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 MR 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 clinical tumor treatment program.
• Launched new services in Emeryville.
• Recognized as MRI Guided Focus Ultrasound Center of Excellence.
• Multiple patent disclosures filed with the Office of Technology and Licensing.

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.

Cardiovascular Imaging
Dominik Fleischmann, MD

The Cardiovascular Imaging (CVI) Division uses dedicated image post-processing techniques to provide unprecedented 3D and 4D visualization and quantification 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 exposures, 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 stable 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].
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.

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. Our procedures 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 training. 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.

Neuroimaging and Neurointervention
Max Wintzermark, 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, verteoplasty 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-MRI) 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-MRI Imaging of cerebral blood flow using 15O water.

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, 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
- 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.
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 UPH 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 patient 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
- Diagnosis of stress injuries in fingers of adolescent competitive rock climbers: Evaluation by ultrasound and MRI. SPR 2017 Annual Mtg: Most Promising Investigator award (Garcia, Jaramillo, Rubesova).
- Validation of ultrasound contrast cystography as an alternative to radiographic voiding cystourethrography. SPR 2017 Annual Mtg: Most Promising Investigator award (Garcia, Jaramillo, Rubesova).
- Development of printed flexible MRI coils as a more comfortable high resolution coil alternative for children (Vasanawala).
- Combined MRI and MR Tractography for pre-surgical planning of brain tumor resections in children to minimize neurologic deficit (Yeom).

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 Tus 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 multi-disciplinary 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 subaortic pulmonary nodular 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 always evaluation and quantitative lung analysis for bronchiectasis obliterans.

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 research. It is the largest, multi-specialty tertiary care center with a 100+ 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 polytraumatic 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 Lou 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.

VA Nuclear Medicine
George Segalli, MD

VA Nuclear Medicine provides a full range of diagnostic and therapeutic procedures using radioisotopes, including general nuclear medicine, PET-CT, SPECT-CT, and cardiac stress imaging. We also work with Interventional Radiology providing Y90 microsphere therapy for liver tumor ablation. 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 treat radiology residents, nuclear medicine residents, and cardiology fellows. We also house the only VA 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.
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 Braverman, PhD

SELECTED FUNDING
The Canary Foundation
Center for Cancer Nanotechnology Excellence for Translational Diagnostics (CCN-TED) NIH/NCI 1L54CA195879- 01 (Gambhir/Wang)
Stanford Molecular and Cellular Characterization Laboratory. NIH/NCI U54 CA199075 03 (Brooks)
Canary Cancer Research Education Summer Training (Canary CREST) Program. NIH/NCI 1 R25 CA217729 01 (Soh/Demirci)

SELECTED PUBLICATIONS


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 bio-informatics. 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.

Micro-environmental forces lead to spatial patterning of benign (green) and malignant (red) cancer cells within a tumor. Image courtesy of Mallick lab.
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/hensing platforms for point-of-care diagnostics with broad medical applications. We have developed tools for detecting cell/cancer biomarkers and isolating exosomes from bodily fluids. We have created microfluidic tools to mimic the cancer micro-environment for investigating metastasis. We made breakthroughs in cell-sorting and single-cell imaging by magnetically levitating cells to isolate circulating tumor cells 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
• 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).

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. resistant). 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.

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.
**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.

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.

Inspired by ImageNet, Stanford Radiology’s research PACS is called *Medical ImageNet*, and is a cloud-based, petabyte-scale database of over 14 million human-annotated non-medical images created by Dr. Fei Fei Li, a Stanford professor of computer science, who 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.

Stanford’s *Medical ImageNet* has already deployed an AI-driven platform called *Medical ImageNet* and is a cloud-based, petabyte-scale database. This system can automatically detect and respond to emergency events, improve image quality, and provide a more efficient user experience for radiologists. The system is designed to be scalable and adaptable to the needs of different medical institutions, allowing for easy integration into existing PACS systems.

*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, 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.
DIVISION LEADERSHIP
Sandy Napel, PhD
Sylvia Plevritis, PhD

SELECTED FUNDING
Qualification and Deployment of Imaging Biomarkers of Cancer Treatment Response. NIH 1 U01 CA212413 (Rubin)
Computing, Optimizing, and Evaluating Quantitative Cancer Imaging Biomarkers. NCI 5 U01 CA174114-02 (Napel/Rubin)
Modeling the Role of Lymph Node Metastases in Tumor-Mediated Immunosuppression. NIH/NCI 5 U54 CA209971 02 (Plevritis/Nolan)

SELECTED PUBLICATIONS

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.
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 hospitals 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.
- Awarded several major grants for developing tools and databases for quantitative imaging.

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.

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 transitional.
- Estimating breast cancer recurrence rates in the U.S. population.
- Simulating 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 (CIBS) Program.

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 (CCE-TD). NIH/NCI 5 U54 CA199075 03 (Gambhir/Wang)
Multiple funding sources by individual faculty grants and industry collaborations

SELECTED PUBLICATIONS


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 20 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. Katherine Wilson, and Dr. Jinghong Xie.
Noninvasive Neurointerventions Lab

Raag Airan, MD, PhD

The Noninvasive Neurointerventions (ni2) Lab is focused on developing novel molecular interventions for interventional 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 ni2 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 ultrasound-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 aspecfic methods to produce these nanoparticles at scales relevant for eventual clinical translation.

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:
  • [18F]FTC-146 PET-MR in healthy volunteers and in patients with CRPS and sciatica.
  • Use of [18F]-FDG PET-MR to diagnose increased nociceptive activity and neural inflammation in patients with chronic pain.
• Publications:
  • First-in-human application of [18F]FTC-146, the sigma-1 receptor radiogand.
  • Redistribution and dosimetry of FTC-146 in healthy subjects.

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 cellular 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 nanoplastforms such as metalin 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 biomimaging and further developed new molecular probes for CLI.

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 radiotageting 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 novel 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 Spleman).
• PET-MRI 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 [18F] FTC-146 are ongoing in both human and equine pain subjects).
• Developed novel clinically translatable imaging probes (e.g., PET NR-14) to study cancer biology, specifically the tumor microenvironment.
basic science lab to clinical imaging applications, technologies have been successfully translated from our therapy. A number of these molecular imaging technologies have been clinically translated.

Modern medicine needs more advanced information. At the 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.

**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.

At our lab, 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.

**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 therapies 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.

**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.

**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 (KGA Li; twice), Priyti Sugaker, Anant Kittale, Maryam Agnighri, Christopher Kleiner, Hossen Nejadnik.
- Patent US 9579349 filed for a tumor enzyme-activatable therapeutic drug that provides image-guided cancer therapy without side effects; now 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.
- First-in-man studies of a new antibody 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 glaucomatosis with tumor treating fields and herbal agents.
- Development of new Raman and photoacoustic molecular imaging strategies for improved cancer detection.
- 10 patients filed on multimodality molecular imaging strategies.

**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 UCI’s 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.

**ACHIEVEMENTS**

- Radioactive Drug Research Committee (RDR) approval of 11C-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 melanoma cell-driven immune responses (PCT/P53/P77).
- First demonstration of imaging 8 cells in a multiple sclerosis mouse model.
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 quantitatively accurate. 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 <100 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.

Body MR Translational Research Lab
Andreas Loening, MD, PhD

The lab focuses on research directed toward expanding the capability of MRI and PET-MRI 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 MRI 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 poison-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.

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 acridine sensor for detection of gastrointestinal cancer.
• Developed 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.
• Developed 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 glioblastoma via novel routes, e.g., intranasa.

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 thera- peutic 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 tiseld, comprehensive cardiac CT protocols for stable chest pain, and CT angiography (CTA) for the image of acute chest pain in the emergency room, (2) new functional cardiac CT applications such as stress myocardiad 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.
• 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.

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 modifications, NfκB-Keap1, Wnt-β-catenin, and NFκB-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 chemotheraphy. 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 methylation 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.
• NfκB-Keap1 antioxidant mechanism in drug resistance and chemotherapy in cancers.
• Studying the role of stem cells in cancer and targeting Wnt-β-catenin and NFκB-Nrf2 signaling to improve cancer chemotheraphy.

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 patient 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 on new photoacoustic probes.
• Dr. Jinghang Xie; 2017 Molecular Imaging Young Investigator Prize.
• Graduate student Tingting Dai; 2016 Edward Curtis Franklin Fellowship.

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 forwards first-in-human clinical trials using near-infrared labeled antibodies (octavimab, 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 anti-body 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 (NSIF) Bio/Medical Seed Grant and 2016 CNNeTD 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. Tam Teraphongphom received a Student Travel Stipend Award, a Women in Molecular Imaging Network Scholarship Award, and an Industry Selected Poster Award from 2016 WAIM.
• Sarah Miller received a Poster Award from the Medical Student Research Symposium at Stanford.
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 therapeutic 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.
• Development of novel techniques for intra-arterial delivery techniques to the pancreas and the synthesis of theranostic nanoparticle platforms.

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 Award, Society of Radiologists in Ultrasound; Sayan Mullick Chowdhury, PhD: 2016 RSNR Intro 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.

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.
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.

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 ¹³C 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 H metabolite distributions throughout the body, and quantifying neurotransmitter levels and cycling rates in the brain.
SELECTED PUBLICATIONS

SELECTED FUNDING

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 brains, liver, and tumors caused by cardiac and arterial pulsations (Moseley).
• Developed robust new ‘H-MRS approach for measuring GABA, glutamate, glutamine, and glutathione in the human brain (Spielman).
• Identified new hyperpolarized 13C MRS probe, 13C-labeled glycerate for measuring glycolysis (Glover).
**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**

- Patrick Ye received a Siebel Scholars fellowship.
- Kim Butts Pauly received a Brain Initiative grant.
- Victoria Yuan received a Bio-X summer fellowship.
- PhD student Rehman Ali received a four year NDSEG fellowship to study speed of sound estimation techniques in the framework of angular coherence theory for ultrasound.
- 5-minute knee MRI protocol.
- Implemented a new, rapid, high resolution knee scan-

**Ultrascanic 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 Riehtian 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 echocardiography patients.
- We developed angular coherence theory for ultrasound and applied it to implement a fast coherence beamforming method.
- 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.

**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 neurological underpinnings of fMRI signals.

**ACHIEVEMENTS**

- 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.

**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, and the use of functional 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 Chaudhary successfully defended their Theses.
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.

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.

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 anatomy and vascular microstructures via functional network connectivities, and thus precisely diagnose and treat complex neurological disease in individual patients. We foster interdisciplinary, mental 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 UPCH to use PJUII 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.

Inverse Geometric 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 CT 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.
The Project Baseline Study
Mapping Human Health and the Transition to Disease

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. Biopspecimens 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 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

Amin, Raag RF1 Noninvasive Neuromodulation via Focused Ultrasound Drug Uncaging

Burns Pauly, Kim R01 MR-Guided Focused Ultrasound Neuromodulation of Deep Brain Structures

Burns 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 Prognosis 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 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 Monitoring of Stem Cell Engraftment in Arthritic Joints with MR Imaging

Datta, Keshav F31 Improved Metabolic Imaging Using Hyperpolarized 13C 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/Felsher U01 (MPI) Modeling and Predicting Therapeutic Resistance of Cancer

Gambhir/Wang U54 (MPI) Center for Cancer Nanotechnology Excellence for Translational Diagnostics (CCNT-TNT)

Gold, Garry R01 Osteoarthritic Quantitative Evaluation of Whole Joint Disease with MRI

Gold, Garry R01 Weight-Boating Imaging of the Knee Using C-Arm CT

Hargraves, Brian R01 Comprehensive MRI Near Total Joint Replacements

Hargraves, Brian R01 Quantitative 3D Diffusion and Relaxometry MRI of the Knee

Hargraves/Daniel R01 (MPI) High-Resolution Whole-Brain MRI at 3.0T

Harris, Kenneth F32 An “F” PET/NIRF Smart Probe for Identifying, Grading, and Visualizing Aneurysm Glomus

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

Los, Brian Jun F31 RF-Transmitter PET Insert for Integrated PET-MRI

Lottin, Craig R01 Exploring a Promising Design for the Next Generation Time-of-Flight PET Detector

Lottin, Craig R01 RF-Printable PET Ring for Acquiring Simultaneous Time-of-Rise PET and MRI Data

Malkhosian R01 (MPI) A Discovery Engine For Reproducible and Comparable Multi-Omics Analysis

Mallick, Jennifer R01 Integration of Diffusion MRI Fiber Tracking and CLARITY 3D Histology for Improved Neuroanatomical Targeting

Napoli/Daniel T32 (MPI) Stanford Cancer Imaging Training (SCIT) Program

Napoli/Pecci R21 (MPI) Tools for Linking and Mining Image and Genomics Data in Non-Small Cell Lung Cancer

Napoli/Rubin U01 (MPI) Computing, Optimizing, and Evaluating Quantitative Cancer Imaging Biomarkers

Pek, Norbert R21 Charge Cloud Tracker: A High-Resolution, High-DQE, Photon-Counting Energy Discriminating X-ray Detector

Pek/Edic/Wang U01 (MPI) High Dose Efficiency CT System

Pinteri/Bernuzzi U01 (MPI) Making Glycosciences via Mass Spectrometry More Accessible to the Greater Scientific Community

Plevris, Sylvia R25 Cancer Systems Biology Scholars Program

Plevris/Clarke U01 (MPI) Clinically-Relevant Regulatory Networks in the Lung Tumor Microenvironment

Plevris/Nidan 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 BONS and Drug-Induced Hepatotoxicity

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.
INDUSTRY FUNDED PROJECTS

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 Vascularization of Cancer Prevention and Early Malignant Action
Cheng, Zhen  Laccunox Group Holdings  Research on Mechanism of Laccunox Products for Treatment of Drug Addiction

OTHER GOVERNMENT FUNDED PROJECTS

Demirci, Utkan  DoD  A Universal Platform for Identification of Novel Lung Cancer Biomarkers Based on Exonomer
Demirci, Utkan  U.S. Army  Biofluidic 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 microfluid assembly for tissue engineering
Demirci, Utkan  NSF  Collaborative Research: EAGER: Biomansurfacting: Bioengineering of 3-Dimensional Brain Surrogate Tissue Models
Iagaru, Andrei  DoD  "Ga Bombesin PET-MRI in Patients with Biochemically Recurrent Prostate Cancer and Noncontiguous Convolutional Imaging
Mallick, Parag  U.S. Dept. of Interior  Accelerating Knowledge Extraction from Large-Scale Multi-Data Sources by Incorporating Prior Knowledge with Deep Learning
Prater, Sharon  U.S. Army  Distinguishing Beign from Malignant Breast Lotion: Does Breast Intestinal Fluid Hold the Answers?
Rao, Jianghong  U.S. Army  PET Imaging Heparanase Activity in Metastatic Prostate Cancer in Tumor Xenografts
Suh, H. Tom  DARPA  Binder-Finder Through Machine-Learning (BFML)
Jagannath, Anand GE Healthcare External Validation of the Next Generation PET-CT System
Jagannath, Anand Piramal Imaging SA [18F]-FDG PET/CT Imaging of Patients with Biochemically Relapsed Prostate Cancer and Equivocal Conventional Imaging Findings
Kohary, Nishita EchoPulse, Inc. 3D Virtual Reality for Endovascular Procedures
Kohary, Nishita Siemens Medical Solutions USA, Inc. Combined Investigations:-wage Handicap and Image Quality Improvement
Kohary, Nishita Silvady, Biopharmaceutics, Inc. A Phase 3 Randomized, Open-Label Study Comparing Pea-Vic (Vaccinia GM-CSF / Thymidine Kinase-Derivatives Versus) 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 "Connectivity" Between Imaging Modalities and the Imaging Informatics Enterprise Aka SYNGO Teamplay Research Investigation
Leung, Ann Genetech, Inc. Methyl-Lung Cancer Screening Care for the Underserved
Levin, Craig Ziteo Medical, Inc. A Hand-Held PET Imaging Camera for Intra-Operative Use
Müller, Patrik GE Healthcare Integration of Multi-Modlar PET-MR Imaging with Multi-Omic Analysis for Prediction of Patient Outcomes in Lung Cancer
Muktinath, Michael MicroVenture, 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 dosimeter
Plevritis, Sylvia Graf Bus Lung Cancer Screening Simulation
Rubin, Daniel Genetech, 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
Ruiz, Brian GE Healthcare Development of Novel Compact UHF MRI Concepts
Sok, H. Tom Merck Sharp & Dohme Corp. Evaluation of Differential Protein Expression in Jarkat T Cell Model of HIV Latency
Siu, Daniel Ying-Ho Biosimilars UK Ltd A "Therocpheres" Advanced Dosimetry Retrospective Global Study Evaluation in Hepatocellular Carcinoma (HCC) Treatment
Siu, Daniel Ying-Ho W. L. Gore & Associees, Inc. An Evaluation of the GORE Conformable TAG Thoracic Endoprosthesis for the Primary Treatment of Anomaly of the Descending Thoracic Aorta
Thakur, Anshul GE Healthcare Targeting Mesenchymal Stem Cells to the Pancreas Using Pulsed Focused Ultrasound: a Novel Application to Treat Diabetes
Thakur, Anshul SEKIS Biomedical, Inc. Improving Pancreatic Islet Transplantation with DNA Immunotherapy
Vasanawala, Shyam GE Medical Systems Wireless Receiver Coil Transponders for MRI
Willmann, Juergen Bracco Diagnostic, Inc. Monitoring Inflammation by Real-Time Fused MRI/Molecular US Imaging in Prostate Acute Terminal Bli
Willmann, Juergen Bracco Diagnostic, Inc. Treatment Monitoring in Transgenic Mouse Model of Inflammatory Bowel Disease using Dual-Targeted Contrast-Enhanced Ultrasound Imaging
Willmann, Juergen EpionRx, Inc. 3D DCE-US for Characterization of RIb-001 Effects
Willmann, Juergen GE Healthcare Development and Testing of a New Passive Carbonation Detection Algorithm for Ultrasound-Guided Therapeutic miRNA Delivery in Hepatocellular Carcinoma
Willmann, Juergen NioRx Pharma LLC B7-403-Targated Contrast Agent for Ultrasonic Detection of Breast Cancer
Willmann, Juergen NioRx Pharma LLC Pancreatic Ductal Adenocarcinoma Targated 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 Computing DRR-MRI Imaging Studies Before and After Treatment for Carotid Artherosclerotic Disease
Zaharchuk, Greg GE Healthcare Technical MRI Improvements in Rapid Imaging with MR Fingerpinting

FOUNDATION AND PROFESSIONAL SOCIETY AWARDS

Anon, Raag The Dana Foundation Towards Clinical Translation of Nonsurgical Neuroumodulation via Focused Ultrasonic Drug Ucncaging
Anon, Raag Foundation of the American Society of Neuroradiology Wada 2.0: Focal Delivery of Anesthetics to the Brains via Nonsurgical Focused Ultrasound
Burns, Paddy, Kim Focused Ultrasound Surgery Foundation Acoustic Parameters of Bone as a Function of HU and MRI
Burns, Paddy, Kim Focused Ultrasound Surgery Foundation Neuronal Focused Ultrasound MR Coil Fabrication and Testing
Dahlsprid, Hetka The Musculoskeletal Transplant Foundation Imaging Immune Responses to Stem Cell Medulated Bone Repair
Ehler, Anton Society for Interventional Radiology Foundation Determining the Threshold for Intervention in May-Thurner Syndrome: an Imaging Informatics Approach
Gambhir, Sanjay Sam The Ben and Catherine Win Foundation A New Strategy to Image Tumor Metabolism in GBM Patients to Help Optimize Anti-Tumor Therapies
Gambhir, Sanjay Sam The Ben and Catherine Win Foundation Gliala Imaging
Gambhir, Sanjay Sam The Ben and Catherine Win Foundation Next Generation Neuro-Oncological Imaging Strategies

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<td>ECOG-ACRIN Medical Research Foundation</td>
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<td>Ruben, Daniel</td>
<td>RSNA</td>
<td>Medical Image Sharing Through a Patient-Controlled Exchange System</td>
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<td>Ruben, Daniel</td>
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<td>Unification of LIOSC Radiology and the RadLex Playbook</td>
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<td>Sagoo, Hrithik</td>
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<td>Quantitative Analysis of Ovarian Cancer with Novel Molecular Ultrasound Agar BRR</td>
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<td>Smith, Bryan</td>
<td>American Association for Cancer Research</td>
<td>Treatment Enhancement by Specific Manipulation of Tumor Immunosuppression</td>
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<td>Strejovica, Tanya</td>
<td>Prostate Cancer Foundation</td>
<td>Promodetically Cleaved Recapture of Oncogenes and Therapeutic Targets in Advanced Castration Resistant Prostate Cancer</td>
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<tr>
<td>Willums, Jaegun</td>
<td>Focused Ultrasound Surgery Foundation</td>
<td>A Novel Genetic Reprogramming Therapy for Hepatocellular Carcinoma Using Focused Ultrasound-Guided Delivery of microRNA</td>
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<td>Yirom, Kristen</td>
<td>Foundation of the American Society of Neuroradiology</td>
<td>Radiogenomic Approaches to Non-Invasive Molecular Subtyping of Pediatric Posterior Fossa Epidermoidoma</td>
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<tr>
<td>Zeinoh, Michael</td>
<td>Donor Duke Charitable Foundation</td>
<td>The Role of Iron and Inflammation in Alzheimer's Disease: from Ex Vivo to In Vivo</td>
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<td>Zeinoh, Michael</td>
<td>The Dana Foundation</td>
<td>The Role of Iron in Alzheimer's Disease</td>
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**STANFORD INTERNAL AND OTHER FUNDING**

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<tr>
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<td>Coulter Endowment Program</td>
<td>Towards Clinical Translation of Noninvasive Neurostimulation via Focused Ultrasound Drug Uncaging</td>
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<td>A Novel “Trigger and Release” Chemical Strategy for Imaging Tumor Hypoxia Ex Vivo</td>
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<td>Bio-X</td>
<td>Technologies for Mixed-Reality Brain Surgery</td>
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<td>Ruben, Daniel</td>
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<td>A Machine Learning Approach to Automated Detection and Characterization of Dendritic Spines in the Mammalian Brain</td>
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<td>Spielman, Daniel</td>
<td>Bio-X</td>
<td>In Vivo Metabolic Imaging of Sonographic Cells Using Hyperpolarized 13C MRS</td>
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</table>

**Funded Projects Summary**

- **NIH**
  - 80 awards
  - $26M
  - 36 awards
  - $2.5M

- **Industry**
  - 59 awards
  - $21M
  - 36 awards
  - $2.4M

- **Non-Profit**
  - 30 awards
  - $3.0M
  - 36 awards
  - $0.3M

- **Other Government**
  - 11 awards
  - $2.5M

- **NIH Subcontracts**
  - 36 awards
  - $2.4M

- **Stanford Internal**
  - 6 awards
  - $0.3M
Radiology Snapshot

203
Radiology Faculty
All Inclusive

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

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

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

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

Sponsored Projects
Total Number of Active Sponsored Projects FY17

Trainees: 250

Faculty: 203

* R01 includes R00, K24, RF1
** Center includes P41 and U54s
Thank you for your Dedication
We appreciate the dedication of staff, including nurses, technologists, informaticians, technicians, and administrators who help make our department as successful as it is today.
Donors, We Thank You For Your Generous Support

Stanford Department of Radiology thanks the following foundations for their generous support of our research in the imaging sciences, including technology development and solutions for the early detection, monitoring, and treatment of disease.

- Alpern Family Foundation
- American Association for Cancer Research
- American Brain Tumor Association
- Association of University Radiologists
- Ben and Catherine Ivy Foundation
- Canary Foundation
- Dana Foundation
- Doris Duke Charitable Foundation
- Etta Kalin Moskowitz Fund
- Foundation of the American Society of Neuroradiology
- Focused Ultrasound Surgery Foundation
- Intermountain Healthcare
- Musculoskeletal Transplant Foundation
- Prostate Cancer Foundation
- Radiological Society of North America (RSNA)
- Rafael and Lisa Ortiz Foundation
- Samarth Foundation
- Sir Peter Michael Foundation
- SITA Foundation
- Society for Interventional Radiology Foundation

We also thank our generous industry partners for their ongoing support.

Supporting the Stanford University Department of Radiology

If you would like to learn more about ways to support any area of research or training in the Stanford Department of Radiology, please feel free to contact any of the following members of the department.

- Sanjiv Sam Gambhir, MD, PhD
  Professor and Chair, Department of Radiology
  sgambhir@stanford.edu

- Yun-Ting Yeh, MBA
  Director, Finance and Administration
  ytyeh@stanford.edu

- Garry Gold, MD
  Professor and Vice Chair, Research and Administration
  gold@stanford.edu

- David Larson, MD, MBA
  Associate Professor and Vice Chair, Education and Clinical Operations
  david.larson@stanford.edu

- Juergen Willmann, MD
  Professor and Vice Chair, Strategy, Finance, and Clinical Trials
  willmann@stanford.edu

- Elizabeth Gill
  Executive Assistant to Dr. Gambhir
  eagill@stanford.edu
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.

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