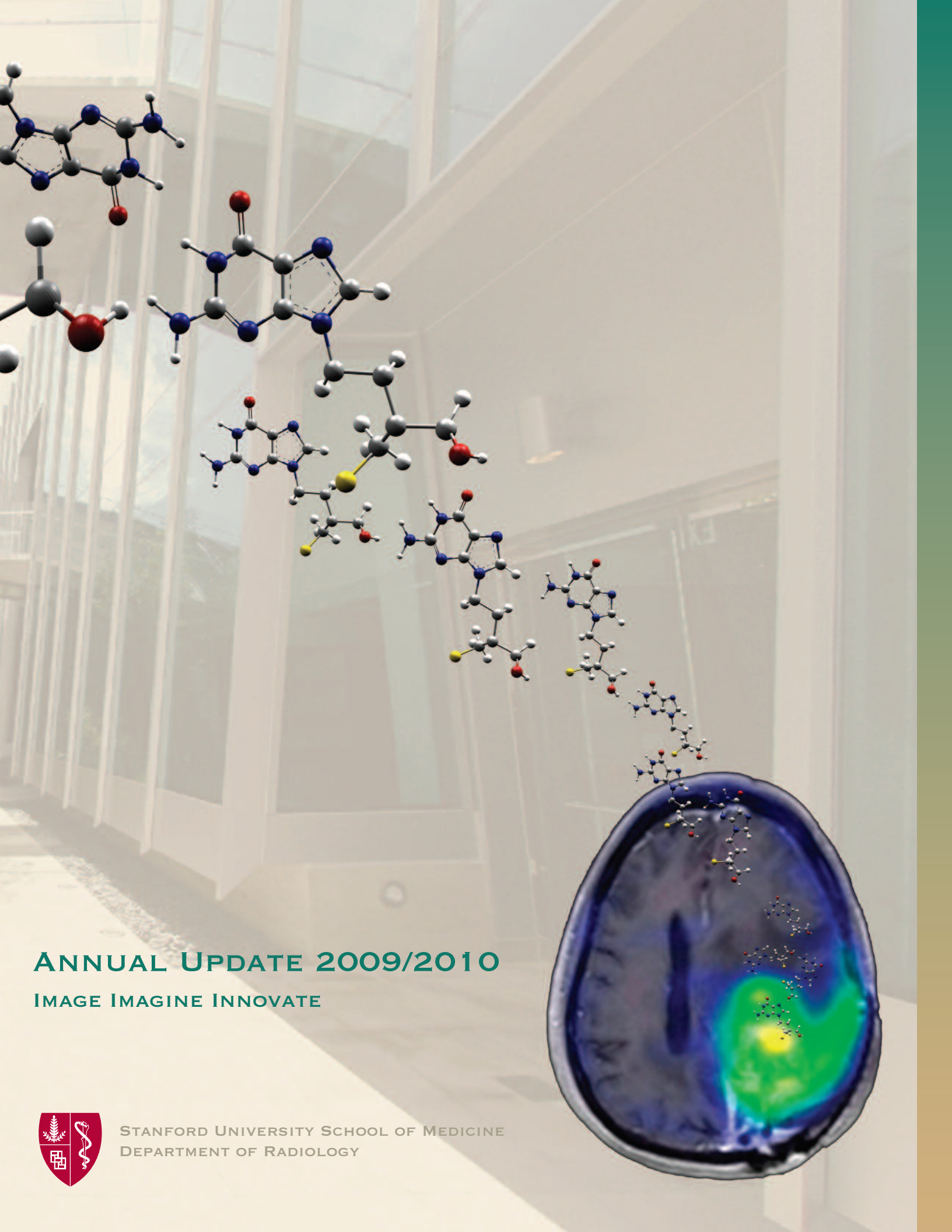


Annual Update 2009/2010

Image Imagine Innovate

Stanford University School of Medicine
Department of Radiology

Stanford Radiology continues to innovate, expanding our programs and developing platform technologies in imaging to unravel the complexities of biology and medicine. Pushing imaging technologies beyond their current boundaries, we are seeing structures that have never been visible before while optimizing imaging for noninvasive techniques.

As you read through this *Annual Update*, you will see the breadth and depth of the Department's recently initiated programs and learn how these advances will drive clinical research as we work to combine data from blood and imaging tests to predict the likelihood of disease. On the research front, we have experienced an explosion fueled by new research space and unprecedented National Institutes of Health (NIH) funding. The Canary Center for Cancer Early Detection at Stanford was launched in 2009. Faculty and students specializing in molecular imaging, early detection, and MR share 20,000 square feet, which includes wet labs, a proteomics facility, and a lab for MR instrumentation development. Further, with our advanced 7T MRI technology, we are exceeding the limits of conventional MR systems by imaging single cells and enhancing the detection of Alzheimer's disease plaques.

Despite an extremely limited NIH grant budget, Stanford Radiology has secured exceptional funding, increasing our overall sponsored research proposals by 85% since 2008 and netting a total of $23 million in NIH awards for 2009. Our faculty have responded magnificently to the opportunity provided by the American Recovery and Reinvestment Act of 2009 (ARRA) with over $4 million in awards. Another extraordinary feat is the renewal of our Center for Advanced Magnetic Resonance Technology at Stanford (CAMRT), which received a perfect NIH-funding score of "10" on its competing renewal grant (NIH P41). This very rare score extends our Center's funding through its twentieth year.

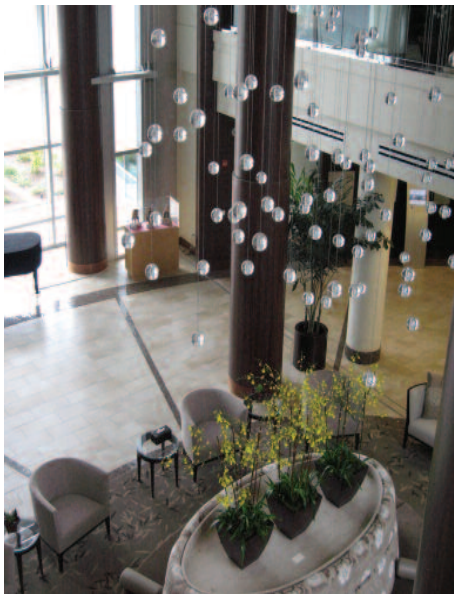
Other accomplishments include our revamped educational curriculum and our new outpatient imaging centers. We are creating courses that exist only at Stanford, exposing medical students to radiology through a variety of interactive methods using the latest educational technology. Infused with the same pioneering spirit that propelled the actualization of our Richard M. Lucas Center for Imaging decades ago, our two outpatient imaging centers not only allow for exceptional technology development but also for new models of patient care. These include the delivery of patient-centric imaging services by increasing the communication between radiologists and patients.

Did You

- "Seminars in Radiology" was introduced this year as a modernized Grand Rounds. It is designed to promote the lively exchange of ideas and collaborations among our faculty and trainees by inviting national and international thought leaders to address important topics in the world of imaging and medicine.
- Voted the 2009 "Best Radiologist Training Program" by AuntMinnie.com, Stanford Radiology was recently recognized for excellence in radiological education.
- Achieving a perfect grant score, the Stanford Radiological Sciences Laboratory (RLS) and the Department of Electrical Engineering's Magnetic Resonance Imaging Systems Research Laboratory (MRSRL) received renewal of their NIH P41 Grant for the Center for Advanced Magnetic Resonance Technology at Stanford (CAMRT). In its fifteenth year

Highlights

Outpatient Imaging



Stanford Medicine Outpatient Center (SMOC), Redwood City

Stanford Radiology has experienced a doubling of its imaging capacity with the addition of 2 new outpatient imaging centers over the last 18 months. Together these new centers house three CT scanners and four 3T MRIs offering our patients the most advanced technology available today. In February of 2009, Stanford Medicine Outpatient Center (SMOC) opened in Redwood City, and is home to our newest advanced imaging center: Stanford Medicine Imaging. Our second imaging center, Stanford Medicine Imaging Center (SMIC) in Palo Alto, occupies 10,000 square feet of space and celebrated its first-year anniversary in June 2009. Our scientists are working every day to markedly improve imaging studies through software enhancements, many of which are not available on commercial scanners. With our four new 3T scanners, the Body MRI Section is developing new methods for fat-water imaging, 3D imaging, and 4D blood-flow imaging. By implementing these MR advances at SMIC and our other sites, our patients benefit immediately from our research in many clinical areas including breast cancer detection, stroke, musculoskeletal imaging, and cardiovascular disease. Furthermore, we have successfully created a new paradigm in imaging services through SMIC's physical layout, which promotes interaction between the patient, radiologist, and technologist to improve patient care through better communication. We have completed a patient preference study at our Center regarding the direct communication of imaging results, and we will soon begin delivering imaging results to patients immediately after their exams as part of a study we have recently initiated with the Department of Oncology.

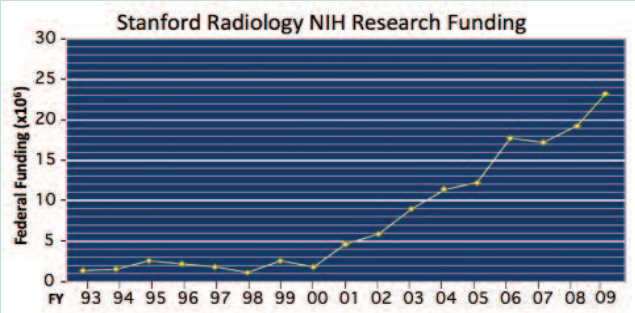
Canary Center for Cancer Early Detection at Stanford

Directed by Sam Gambhir, MD, PhD, the Canary Center for Cancer Early Detection at Stanford officially opened in June, 2009, with a ribbon-cutting ceremony at our newly-leased facility in Palo Alto and with a funding commitment of $20 million from the Canary Foundation and Stanford University. Occupying approximately 20,000 square feet, the Canary Center houses state-of-the-art core facilities and fosters collaborative research programs in molecular imaging, proteomics, chemistry,

Know?

of existence, the CAMRT's renewal extends its funding through its twentieth year.

- National Institutes of Health (NIH) funding to Stanford Radiology has grown from $6 million in 2002 to $23 million in 2009.

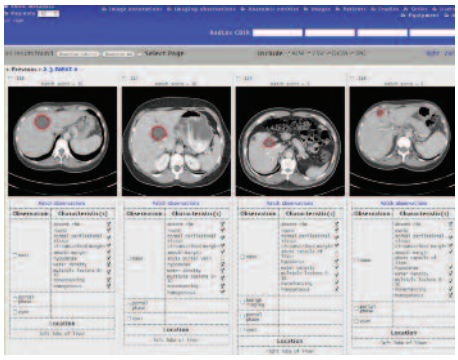


and bioinformatics to develop blood and imaging tests for early cancer detection. The proteomics facility houses cutting-edge mass spectrometry platforms dedicated to the discovery and validation of blood protein biomarkers. The chemistry core will enable the specific design and refinement of molecular imaging agents for early detection that will undergo preclinical testing using in vivo and ex vivo model systems, including patient blood and tissue samples. The Department of Genetics also has lab space at our Center to facilitate genomics research. These collaborative efforts will be unified through coordinated bioinformatics platforms to track specimens and facilitate the exchange and analysis of data. Canary Center research programs will also actively interface with other facilities and programs on campus, including the Molecular Imaging Program at Stanford (MIPS) and the Center for Cancer Nanotechnology Excellence Focused on Therapy Response (CCNE-TR). Collectively, these initiatives have extensive links to the Cancer Center at Stanford, forming a direct pipeline for the translation of early cancer detection methods into clinical trials and practice. Other new developments being pioneered by our Center include the use of ultrasound with targeted microbubbles to detect tumors in the 3-5 mm range. This novel technology allows for the identification of different biomarkers at levels that are 10-100 fold better than the most sensitive enzyme-linked immunosorbent assay (ELISA) tests currently available. A clinical trial using the targeted microbubbles for ovarian cancer detection is in the planning stages.

Canary Center Ribbon Cutting, June 11, 2009

ISIS (Information Sciences in Imaging at Stanford)

Last year, ISIS was established with a mission to increase the information derived from imaging data by discovering relationships among imaging features; molecular markers; pathological and laboratory reports; and patient outcomes. Since then, we have made substantial progress. To speed data collection and database building, we have developed collaborations with liver and thoracic surgeons inside and outside of Stanford. In addition, ISIS is exploring the availability of image and genomic data for retrospective analysis, and has begun to build a retrospectively collected database of annotated images of liver lesions for developing software tools. Biomedical Image Data Manager (BIMM) is our prototype database and semantic feature mining software, which allows for the retrieval of similar images based on semantic annotations. Our novel bioinformatics pipeline may enable us to predict the likelihood of a patient's response to a molecularly targeted drug directly from imaging data to capitalize on the genomic data that already exist.



Biomedical Image Data Manager (BIMM) collects and allows examination of relationships between annotated images.

High-Field MRI Program

Our Program has made significant progress this year under the leadership of

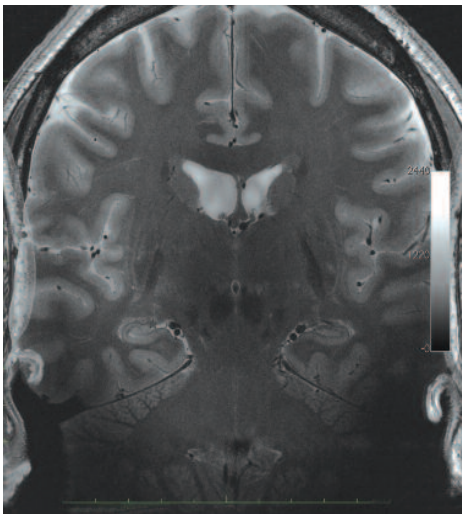
Career Awards

The award winners below have profoundly impacted radiology through their contributions. In addition, many Radiology faculty, staff, and students have been honored for their achievements. See a complete list on our Radiology website at http://radiology.stanford.edu/research/awards.html.

Gary M. Glazer, MD, Named the 2009 RSNA Gold Medal Award Winner
The RSNA has conferred its highest honor, the Gold Medal, on Gary M. Glazer, MD, Emma Pfeiffer Merner Professor in the Medical Sciences, for his exemplary service to the science of radiology. Under Dr. Glazer's 20 years of leadership as chair of the Department of Radiology, Stanford's programs have grown to become epicenters for innovation and education through his unique ability to envision and generate advances in the field. Among his many contributions, he helped establish the Medical School's Richard M. Lucas Center for Imaging, which serves as an international resource bringing together physicists, engineers, chemists, molecular biologists, and physicians to create novel breakthroughs in medical imaging.

Sam Gambhir, MD, PhD, Selected as the 2009 RSNA Outstanding Researcher
Dr. Sam Gambhir has been chosen as the 2009 Outstanding Researcher by the RSNA for his unique contributions to the field of radiology. A world-renowned leader in the field, Dr. Gambhir is transforming the imaging sciences and patient treatment through his expertise and leadership in cellular and molecular imaging. He serves as chief of the Nuclear Medicine Division; director of the Molecular Imaging Program at Stanford (MIPS); and head of the new Canary Center for Cancer Early Detection.

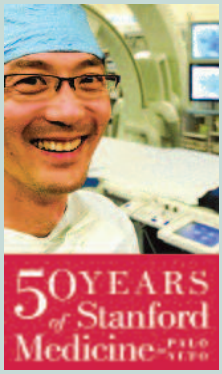
Program Director Brian Rutt, PhD. Since his arrival in early 2009, Dr. Rutt has forged connections in high-field MRI by identifying ways in which the Program can collaborate with different sections within Radiology as well as with other Stanford groups. While transforming conventional MR systems to image single cells, he is developing a new MRI hardware laboratory dedicated to producing innovative gradient, shim, and RF coils. Housed in the same building as the Canary Center for Cancer Early Detection, the High-Field MRI Program is also exploring the use of high-field magnetic resonance imaging to depict the plaques in Alzheimer's disease. By improving our understanding of the developing and aging brain, our Program will advance neuroimaging research at our Center for the Aging Brain and Cognitive Disorders, which is a collaboration among the Stanford Radiology, Neurology, Psychiatry, and Psychology Departments investigating new diagnostic tools and therapies for neurodegenerative and preclinical cognitive decline.



Coronal image of a human brain acquired at 7T MRI showing improved image uniformity and quality.

Did You Know? (cont.)

- To commemorate Stanford University Medical Center's fiftieth anniversary, Daniel Sze, MD, PhD, associate professor of radiology, is featured in surgical scrubs on a life-size banner. A tribute to patient care, the banner with Dr. Sze's photo is one of six designs hanging on campus and along its perimeter.
- "Speed Dating – Finding Your Research Collaborator" is a new program to enhance interdisciplinary collaboration among Stanford researchers and clinicians. Faculty, residents, and students attend quarterly sessions featuring four-minute research presentations delivered by multiple clinical and research faculty to help

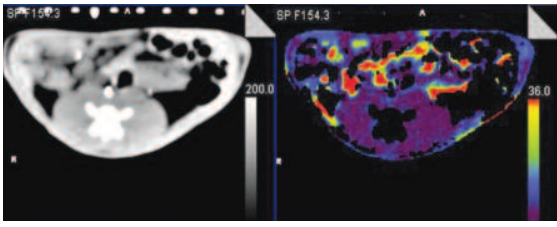


Selected Section Updates

Interventional Radiology

With a 30% increase in productivity over last year, Stanford Interventional Radiology (IR) is one of the busiest centers on the West Coast, offering minimally invasive image-guided treatments for a wide variety of diseases, with a particular focus on interventional oncology; deep venous thrombosis (DVT); and peripheral arterial disease. We offer amazing new cancer treatments for our patients by employing cutting-edge therapies to kill tumors without surgery, such as radioembolization and chemoembolization. One out of ten chemoembolizations in the United States is completed by our Section. To better serve patients, we opened two new procedure rooms in the Advanced Medicine Center (AMC)/Cancer Center for simple cases. This past year, we have also experienced a significant increase in volume for the treatment of arteriovenous and venous malformations, and we are now a national referral center for the retrieval of high-risk inferior vena cava (IVC) filters. In addition, we are completing preclinical studies for pancreatic irreversible electroporation, and we plan to initiate the first in-man studies for pancreatic cancer this year. We continue our research in gene therapy for cancer, DVT, and pulmonary embolism (PE) as well as our research on the use of DYNA-CT for the intra-arterial treatment of cancer. To keep our Section growing, we offer a preeminent national medical student clerkship in IR, and we continue to expand our faculty.

Computed Tomography (CT)



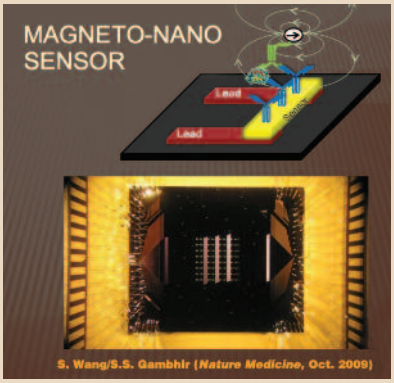
Initial results obtained from a small animal feasibility experiment show a maximum intensity projection (MIP) image of a rat through the mid-abdomen (left) and tissue permeability (in mL/100mL/min) (right).

One of our most recent research initiatives includes work in body perfusion CT. The latest CT technology allows whole organ perfusion measurements and most importantly, perfusion measurements of tumors. We hope that perfusion CT can be used as a predictor of treatment response by measuring blood flow to a tumor before and after treatments such as chemotherapy, radiation treatment, and anti-angiogenesis therapies. Animal experiments and pilot

Research Spotlight

Magneto-Nano Sensors for Early Disease Detection

We have developed a biosensor chip that contains an array of 64 magneto-nano sensors which can detect different cancer-associated protein biomarkers in concentrations as low as one part out of a hundred billion. Because we believe that the detection of disease will require four to eight biomarkers, the chip could potentially ascertain multiple cancers simultaneously.



Body fluid placed on the sensors is incubated with biotinylated detection antibodies, which bind to the antigens in the fluid of interest. Streptavidin-labeled magnetic nanoparticles are applied and attach themselves to the antibodies, creating a detectable magnetic signal.

broaden awareness of Radiology's research efforts.

- Routing UCSF 42-12 in flag football, our Stanford Radiology residents, faculty, and fellows racked up their second victory against UCSF, after soundly defeating them in softball 32-8. UCSF has challenged Stanford Radiology to a third contest: a soccer game. The rivalry continues!

studies have been designed by our body perfusion research group in collaboration with several colleagues from other Stanford clinical departments to conduct early phase experiments in perfusion CT with the ultimate goal of translating research into routine clinical application for oncology patients. Other CT technologies we are exploring include dual-energy CT. Our early results in this area already show great promise for clinical application, such as the elimination of vessel wall calcifications in CT angiography through the improved ability of dual-energy CT to distinguish iodinated intravascular contrast agent from calcified atherosclerotic plaque in the vessel walls.

Molecular Imaging

Scientists in the Molecular Imaging Program at Stanford (MIPS) are collaborating on new efforts in diagnostics, small animal imaging, and clinical imaging, which will play an integral role in helping to translate discoveries to the patient bedside. One of our latest research projects features the translation of a new PET imaging agent to image angiogenesis in patients for the first time. This new peptide agent images integrins and is radiolabeled with Fluorine-18 to allow PET imaging. Along with our research achievements, our funding continues to increase with many new R01 grants, some of which are being used to translate strategies to the clinic. Training efforts include the Molecular Imaging Seminar Series and the Nanobiotechnology Seminar Series, which help to educate scientists about molecular imaging.

Abdominal Imaging

Our Abdominal Imaging Group is developing new reformatting techniques and initiating new studies in ablation, such as MR-guided high-intensity focused ultrasound ablation of prostate and pancreatic cancers. Other projects include 3D MDCT of pancreatic cancer and periampullary lesions; photoacoustic imaging using capacitive micromachined ultrasonic transducer (cMUT) technology; MRI of obstructive sleep apnea; and molecular imaging using ultrasound for early cancer detection. We are also creating Bayesian networks for decision support of thyroid biopsies.

Musculoskeletal Imaging

In 2009, we expanded our MSK services with the opening of a new advanced outpatient imaging facility, Stanford Medicine Imaging, located at Stanford Medicine Outpatient Center, Redwood City, (SMOC). With a primary focus on MSK, Stanford Medicine Imaging houses two of the most advanced 3T MRIs; one state-of-the-art CT scanner; as well as two fluoroscopy rooms dedicated to MSK procedures. Some of the ongoing research studies at our facility include three-dimensional isotropic imaging of joints. In addition, our Section continues to provide dedicated MSK ultrasound coverage for diagnostic and interventional ultrasound studies as well as ongoing MSK radiology services for the San Francisco 49ers and Stanford Athletics. As a result, MRI referrals have increased by up to 35% for some of our sports medicine physicians. We have also initiated new methods in radiology informatics for teaching and research. Other efforts include MR imaging of metal implants in joints and the spine; imaging of pain using high-field MRI; and sodium MR imaging of articular cartilage in patients with early osteoarthritis.

Neuroradiology

With the opening of our new outpatient imaging centers, the Neuroradiology Section is at the forefront in state-of-the-art high-field MRI and CT capabilities. New clinical applications, developed in collaboration with Neurosurgery and Neurology, such as brain perfusion, diffusion tractography, and functional MRI, are becoming integrated into critical patient-care decisions. Innovative interventional neuroradiologic techniques in cerebral revascularization and embolization, as well as in spinal vertebroplasty, are being developed and applied at Stanford. In education, our faculty have reached beyond the Department and are key educators in referring departments, including Otolaryngology, Radiation Oncology, Neurology, and Neurosurgery. Stanford Neuroradiology has also played a role in the Center for the Aging Brain and Cognitive Disorders and in the collaborative Interventional Spine Center. (See "High-Field MRI Program" under "Highlights.")

Pediatric Imaging

Exciting research in Stanford Pediatric Radiology includes the use of MR choline spectroscopy to measure short-term tumor response to novel new drugs; the study of carbon-based molecular probes to image

Research Spotlight

Visualizing Radiofrequency Ablation Lesions with Iodine Contrast-Enhanced Cardiac C-Arm CT

Prior to our study, there was no way to visualize the lesions created by ablations in patients while they were undergoing cardiac interventional procedures. Using electrocardiogram (ECG)-gated C-arm CT imaging, we were able to visualize radiofrequency ablation lesions in the myocardium for the first time during a cardiac interventional procedure.

Two lesions visible as hypo-enhanced regions in the first-pass image (left) and corresponding lesions on the pathology image (right).

inflammatory arthritis using high-field MRI; the development of faster and more robust methods of pediatric MR imaging to diminish requirements for general anesthesia and radiation associated with CT and fluoroscopy; the implementation of MR imaging for the evaluation of hepatobiliary and GI tract diseases; the measurement of the impact of using ultrasound before abdominal CT in the diagnosis of acute appendicitis; and the reduction of the general CT radiation dose in the pediatric population. Lucile Packard Children's Hospital (LPCH) houses a 3T MR as well as a portable head CT scanner.

Did You Know? (cont.)

- A 2,500-year-old mummy of an Egyptian priest from the Fine Arts Museum in San Francisco was scanned by Rebecca Fahrig, PhD, associate professor of radiology, in cooperation with the Akhmim Mummy Studies Consortium, at the Department of Radiology's AxiomLab.
- Stanford Medicine Outpatient Center in Redwood City opened in early 2009. With the added outpatient capacity, our radiologists examined more than 25,000 MRI and CT patients at all of our outpatient imaging facilities in the last year. (See "Outpatient Imaging" and "Musculoskeletal Imaging" under "Section Updates.")

Breast Imaging

Our Breast Imaging Program has recently implemented vacuum-assisted core biopsies in ultrasound that enable the minimally invasive removal of multiple samples of tissue. In addition to clinical growth, we have expanded our core research areas including elastography of breast masses; optical scanning of breast masses with hand-held probes; phantom studies of nanotubes using an optical breast scanner; and breast density on mammography and MRI. Our Program continues to collaborate with Malmo General Hospital in Malmo, Sweden, by exploring advances in breast tomosynthesis.

PET/CT

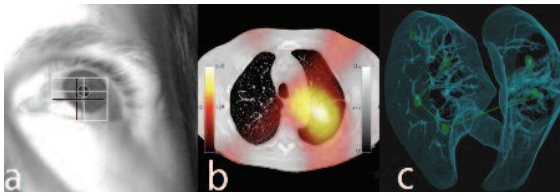
The clinical utilization of Stanford PET/CT has grown significantly. With a single PET/CT scanner dedicated to clinical service, we scan approximately 250-290 patients per month. While lymphoma continues to be the primary cancer evaluated by PET/CT, the profile of oncological patients is remarkably diverse and includes a significant number of rare malignancies such as soft tissue sarcomas and pediatric neuroendocrine tumors. Currently, notable projects include concurrent NaF + FDG PET/CT imaging in cancer; 18F-5FU PET/CT for monitoring bevacizumab therapy; and a comparison of whole-body MRI and DCE MRI to FDG PET/CT for various cancers. In 2010, the current PET/CT will be replaced by two state-of-the-art PET/CT scanners that feature ultrafast scintillation crystal technology coupled to 64-slice and 16-slice CT scanners.

Radiological Sciences Laboratory (RSL)

Stanford's RSL is working to speed basic science discoveries through initiatives such as its newly established High-Field MRI Program. Other new projects include technological renovations to the Richard M. Lucas Center for Imaging, home to the Radiological Sciences Laboratory (RSL), such as the upgrading of the second 3T magnet installed last year as a prototype to production hardware. The system has proven remarkably stable and is in full use. We have also added substantial infrastructure for research imaging experiments, including a newly installed custom eyetracker.

This past year, we increased our collaborations through our NIH-funded Center of Excellence, the Center for Advanced Magnetic Resonance Technology at Stanford (CAMRT). In addition to the development of technology projects, the CAMRT provides support for collaborations and service use of the facilities by users in the Radiology Department as well as more than 75 faculty and 200 other users from at least 14 campus departments.

Image Display and Analysis: 3D Lab



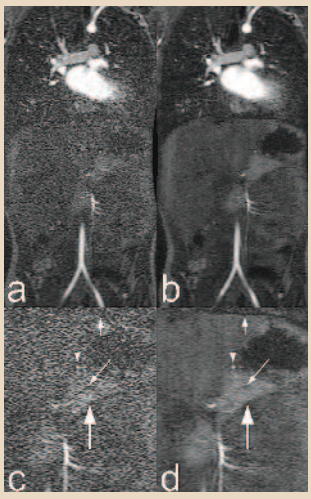
Mapping Eye Movements in 3D – Analyzing Gaze Paths When Interpreting Volumetric CT Data: *An infrared beam detects the glint in an observer's eye (A). The gaze direction is mapped and then meshed with lung CT data (B), which is used to map three-dimensional gaze paths that illustrate how radiologists explore volumetric CT data (C).*

The 3D Medical Imaging Laboratory is an international leader in clinical care, teaching, and research in medical imaging analysis. With the addition of our new outpatient centers, our average monthly 3D volume over the past year has increased to approximately 960 examinations, and we have processed over 67,000 examinations overall since our inception in 1996. To expedite workflow, future clinical applications include the migration of all 3D software applications to centrally located servers for the immediate sharing of post-processed patient data. Educational activities include the training of Stanford Radiology fellows, residents, and international visiting scholars.

Research Spotlight

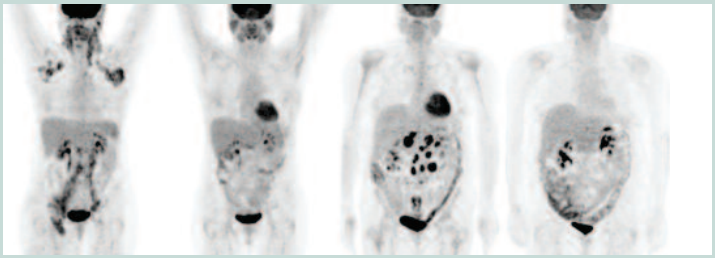
Innovations in Pediatric MR Imaging

In pediatrics, we are reducing the need for anesthesia for children undergoing MRI by creating novel MRI hardware designed specifically for children; generating high-fidelity motion detection and correction methods; and devising innovative methods of reconstructing imaging from ultra-fast scans.



Breath-hold post-gadolinium MRI in a nine-year-old male with hypertension: traditional image reconstruction is inadequate for high-speed imaging (left images a,c), whereas a novel reconstruction method (right images b,d) shows excellent delineation of the pancreas (big arrow); pancreatic duct (middle arrow); and diaphragm (small arrow).

■ The 2009 Society of Nuclear Medicine Image of the Year Award was received by Andrei Iagaru, MD, instructor of nuclear medicine; Erik Mittra, MD, PhD, instructor of nuclear medicine; and Michael Goris, MD, PhD, professor of radiology (nuclear medicine) for their image comprised of two sets of before-and-after PET scans of two patients showing the effectiveness of two radioimmunotherapy agents in treating non-Hodgkin's lymphoma (NHL).



Veterans Administration Hospital in Palo Alto, California

The VA Radiology Section continues its extensive renovation of the Diagnostic Radiology Center (DRC) to accommodate new, advanced technology. A state-of-the-art dual-energy 64-slice CT scanner has just been installed and a new 3T MRI scanner will soon be installed. Installation of a new biplane angiography suite has just been completed, and we continue enjoying outstanding images and utility from the integrated CT/angiography suite installed several months ago. New ultrasound equipment is scheduled to be added shortly, along with new radiography and fluoroscopy suites that add bariatric capability to our modern instrumentation. The VA Palo Alto is one of only four VA hospitals in the U.S. chosen to be centers of care for returning veterans with multiple injuries.

Education

Resident and Medical Student Education

Led by our first associate chair of education, Michael Federle, MD, we have completely renovated the curriculum for our residents and fellows by implementing didactic lectures; interactive case conferences; and "hot seat" conferences that cover the entire spectrum of diagnostic and interventional radiology. For first-year residents, we have instituted a two-month "Radiology Boot Camp" that serves as an introduction to radiology by providing a series of didactic and case conferences as well as access to an internet resource designed to enhance interactive, self-directed learning. We recently created a new online course, "201: Radiology, Anatomy, and Pathology," for first- and second-year medical students as well as graduate students, and the development of a new radiology course, "RadPrimer," is also underway. The first of its kind, our new "RadPrimer" course will include patient cases and online textbooks.

Continuing Medical Education Program (CME)

Over the past 19 years, the Stanford Department of Radiology has constructed a world-class CME program for practicing physicians, radiologic technologists, industry-based engineers, and scientists. In fulfillment of its educational mission, the Department continues to disseminate radiological advances while establishing an international reputation for excellence and innovation in postgraduate medical education. In 2009, Stanford Radiology presented 14 courses to over 3,000 registrants. For 2010, we have been motivated by the economy and other policy changes to reduce the number of our traditional conferences and to expand the international focus of our programs. There are eight CME meetings planned for the upcoming year and several new (non-CME) educational efforts underway. We have just completed our second joint conference in China, which was developed in partnership with the Chinese Society of Radiology (CSR) and included 300 radiologists from throughout the region. We have an agreement signed with CSR to continue this symposium annually. Additionally, we are planning two one-week, advanced training programs on campus for physicians from China and Europe. These programs will be modeled after our highly successful course for the Japanese Society of Radiological Technology, which was offered for the fourth time this past summer and will be available again in 2010. For a list of upcoming CME courses, please visit our website: http://radiologycme.stanford.edu.

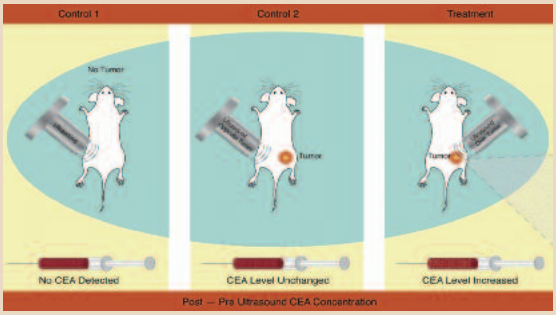
New Faculty and Instructors

We are delighted to welcome the following: **Ramasamy Paulmurugan, PhD,** Acting Assistant Professor, Molecular Imaging Program at Stanford (MIPS); **Stefan Hura, MD,** Clinical Instructor, Musculoskeletal Imaging (MSK); **Amelie Lutz, MD, PhD,** Clinical Instructor, Abdominal Imaging and MSK; **Erik Mittra, MD, PhD,** Clinical Instructor, Nuclear Medicine; **Arutselvan Natarajan, PhD,** Instructor, MIPS; and **Peter Poullos, MD,** Clinical Instructor, Abdominal Imaging and Outpatient Imaging.

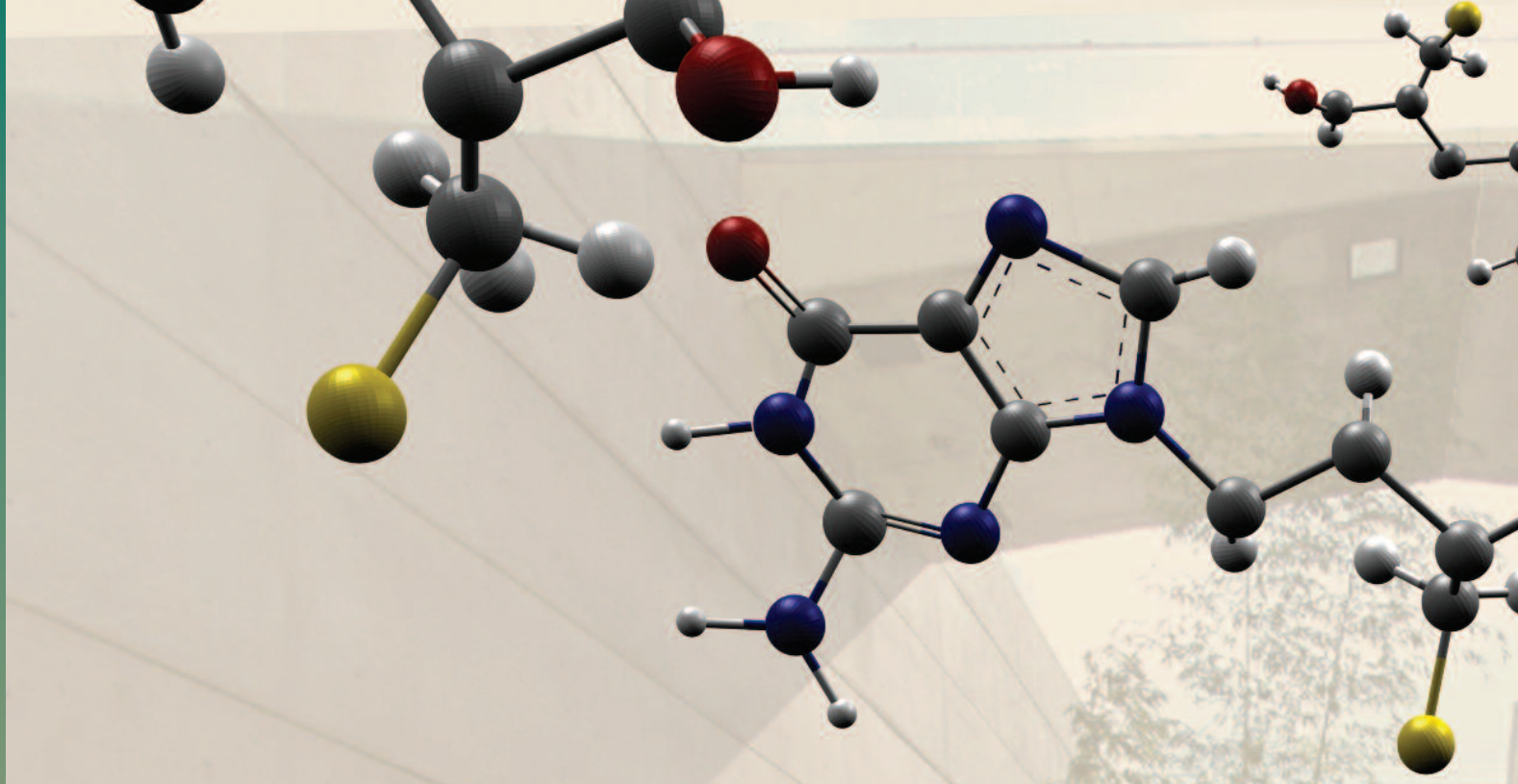
Research Spotlight

Applying Ultrasound to Amplify and Localize Tumor Biomarkers

Using ultrasound energy directly applied to tumor cells, we have increased the concentration of biomarkers in blood as well as localized the source of biomarker signal in cell culture experiments and mouse tumor xenograft models using the human colon cancer cell line LS174T. Developing a noninvasive strategy to determine the presence and localization of disease earlier and more accurately will greatly improve patient care.



Ultrasound caused an increase in CEA biomarker release only when directly applied to the tumor.



Stanford University School of Medicine
Department of Radiology
Lucas Center
Stanford, CA 94305-5488
http://radiology.stanford.edu

Produced by Gary M. Glazer, MD;
Julie Ruiz, PhD; and Susie Spielman
Cover Design by Amy Morris
Stanford University Department of Radiology
Email comments to
jaruiz@stanford.edu

STANFORD
SCHOOL OF MEDICINE
Stanford University Medical Center