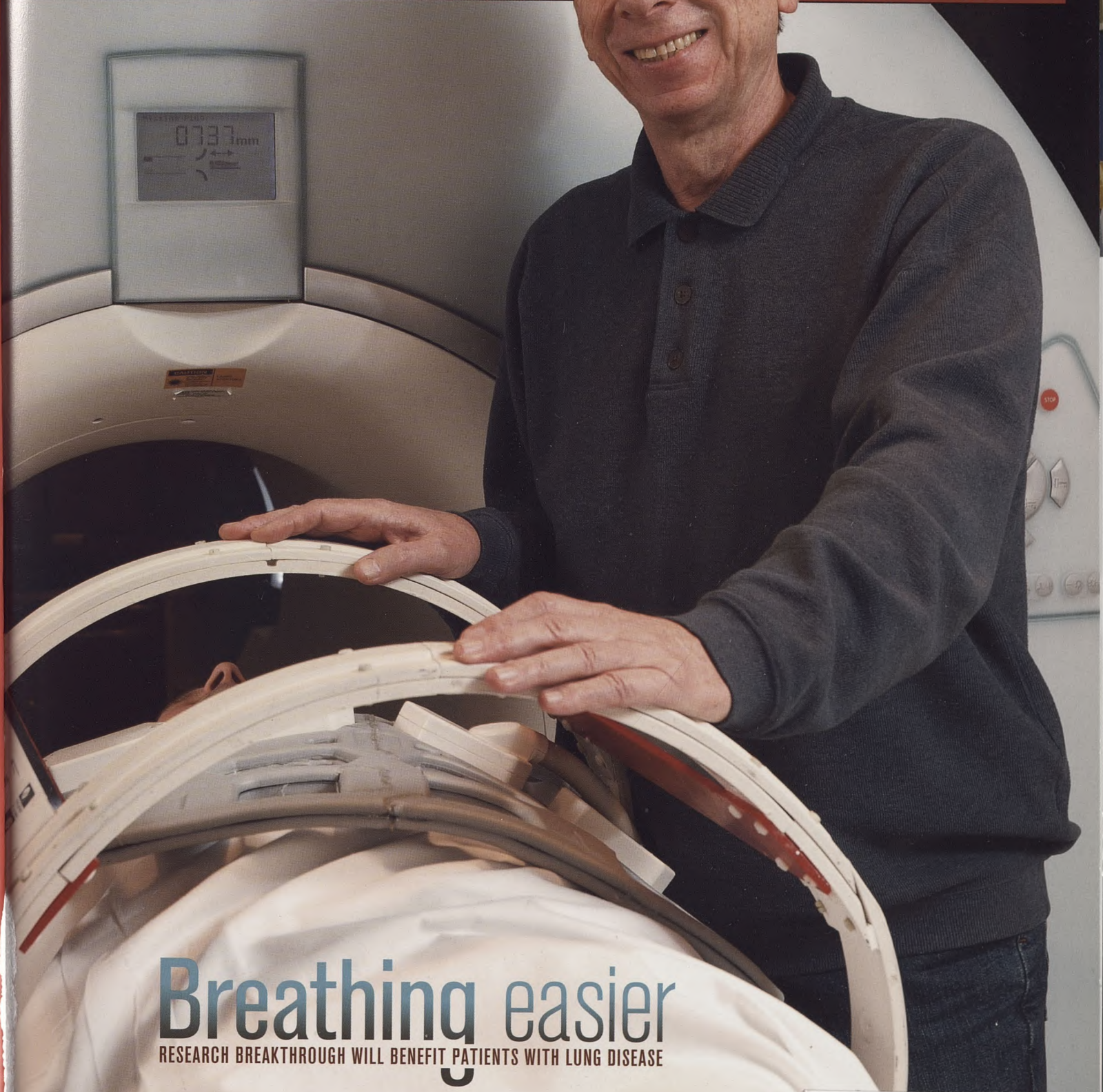


FOCAL SPOT, FALL/WINTER 2010-2011

VOLUME 41, NUMBER 2

# FOCAL SPOT

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MIR faculty and staff at RSNA's 96th  
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# CONTENTS

FOCAL SPOT  
FALL/WINTER 2010-2011  
VOLUME 41, NUMBER 2

## Circa 1970s

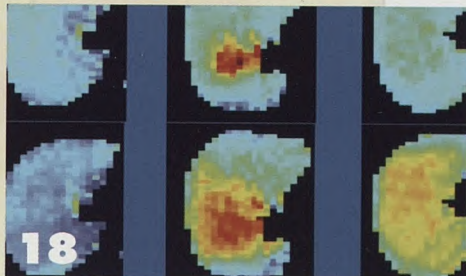
Some of the earliest cardiac angiography studies were conducted at Mallinckrodt Institute. Prior to the introduction of spiral scanning and multislice technology, as provided by computed tomography, earlier technologies were too slow to capture high-resolution cardiac images.



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## 2.....SPOT NEWS



27.....FYI

### 4 RSNA 2010: Personalized Medicine

MIR faculty and staff were among the 60,000 medical and science professionals attending the 96th Annual Meeting of the Radiological Society of North America.

### 10 A LINC to the History of Personal Computing

An interactive exhibit currently on display in the School of Medicine's Bernard Becker Library is a tribute to the pioneering Laboratory Instrument Computer, regarded by many as the first personal computer.

### 15 Cancer Research Imaging Camp 2010

For the second consecutive year, Mallinckrodt Institute hosted an intensive course on *in vivo* and live cell-imaging techniques, sponsored by the National Cancer Institute.

### 18 Breathing Easier

Scientists are using a technique, developed at Washington University Medical Center and its associated data analysis to identify living lung pathology at very early stages.

### 23 A History of MIR

The Mallinckrodt Institute lobby is home to a poster display depicting historical events throughout the Institute's 75-plus years of providing top quality clinical, research, and educational services.

ON THE COVER Dimitriy Yablonskiy, PhD, uses helium-3 morphometry and magnetic resonance imaging to measure levels of damage to the living lung. Photograph by Tim Parker

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# SPOT NEWS

## Nanotechnology research program focuses on heart and lung diseases

An \$18 million award from the National Heart, Lung, and Blood Institute of the National Institutes of Health will fund five years of collaborative research at five institutions: Washington University School of Medicine (WUSM), Texas A&M University, University of Texas Southwestern Medical Center, and the University of California, Santa Barbara and Berkeley. Coprincipal investigators are Michael Welch, PhD, professor of radiology, of chemistry, and of molecular biology and pharmacology, WUSM, and Karen Wooley, PhD, of Texas A&M University.

Aimed at finding nanotechnology-based therapies and diagnostic tools for treating heart and lung diseases, the research initiative includes four principal projects:

- Develop nanoparticles to aid clinicians in the early detection of atherosclerosis. Group leader: Pamela Woodard, MD, professor of radiology, WUSM.
- Develop targeting molecules to facilitate nanoparticle binding with cell receptors present in heart and lung diseases. Group leader: Karen Wooley, PhD.
- Develop nanoparticles for treating patients with cystic fibrosis. Group leader: Carolyn Cannon, MD, PhD, University of Texas Southwestern Medical Center.
- Use nanoparticles to diagnose and treat acute lung inflammation. Group leader: Steven Brody, MD, WUSM.



At the award ceremony, Welch (second from right) received a Distinguished Investigator Award, presented by (left to right) Karen O'Malley, PhD, professor of anatomy and of neurobiology; Larry Shapiro, MD, executive vice chancellor for medical affairs and dean; and Diana Gray, MD, professor of obstetrics and gynecology and of radiology, and associate dean for faculty affairs. Photograph by Bob Boston, WUSM.

## Welch receives faculty award

Michael Welch, PhD, professor of radiology, of chemistry, and of molecular biology and pharmacology, was one of 11 Washington University School of Medicine faculty members honored at the 2011 Distinguished Faculty Awards ceremony.

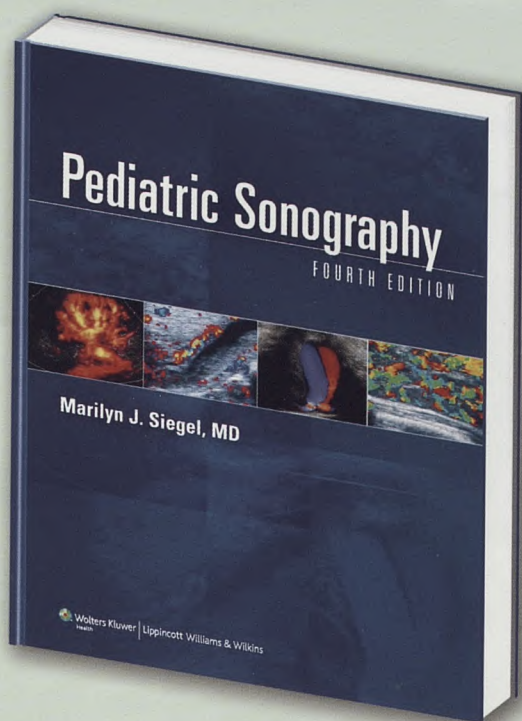
Cosponsored by the Dean's office, the Office of Faculty Affairs, Central Administration, and the Executive Committee of the Faculty Council, the awards recognize outstanding achievement in clinical care, research, teaching, and community service.

# AWARD



## New edition of pediatric imaging textbook available

*Pediatric Sonography*, now in its fourth edition, has been called the “go-to book on pediatric ultrasound.” Authored by Marilyn Siegel, MD, professor of radiology and of pediatrics, this latest edition provides a complete working knowledge of the latest scanning technologies and the most recommended clinical applications in pediatric and adolescent patients. Seventeen chapters—including 14 site-specific chapters—and more than 1,500 ultrasound images offer expert guidance in understanding disease processes. Published by Lippincott Williams & Wilkins, *Pediatric Sonography* provides the clinician with the necessary tools to rapidly recognize normal and abnormal pediatric anatomy.



## MIR training programs earn top rankings

In its summary review of 55 fellowship programs, the American Board of Radiology ranked Mallinckrodt Institute's Neuroradiology Fellowship Program as number one, based on fellow performance in the examination for Certificate of Added Qualifications. Annually, nine fellows are accepted into the one-year program. Program director is Katie Vo, MD, associate professor of radiology; assistant program director, Michelle Miller-Thomas, MD, assistant professor of radiology.

AuntMinnie.com—the leading online resource for radiology professionals—annually presents awards (called The Minnies) to recognize excellence in radiology. Mallinckrodt Institute's Diagnostic Radiology Residency Program received the 2010 top award for radiology residency training. Program director is Jennifer Gould, MD, assistant professor of radiology.

## Of note

- **John Kotyk, PhD**, research associate professor of radiology, was elected to a one-year term as treasurer of the Academy of Molecular Imaging.
- **David Loy, MD, PhD**, instructor in radiology, and **Jonathan McConathy, MD, PhD**, assistant professor, were appointed codirectors of the Institute's Research Residency Program.
- **Jonathan McConathy, MD, PhD**, assistant professor of radiology, was elected to a three-year term on the Board of Directors for the Society of Nuclear Medicine's Molecular Imaging Center of Excellence.
- **Robert McKinstry, MD, PhD**, professor of radiology and of pediatrics, was appointed director of Mallinckrodt Institute's Center for Clinical Imaging Research.
- **Stephen Moore, MS**, research assistant professor, received the Second Annual Ad Hoc Harley Award from Healthcare Standards for his outstanding contributions to the forwarding of healthcare standardization, ensuring that “more than 1000 products work with each other, using more than 200 different specifications.”





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## MIR PRESENTATIONS AT RSNA 2010

### EDUCATION EXHIBITS AND SCIENTIFIC POSTERS

**Vincent Mellnick, MD; Russell Allman, MD; Elizabeth Sheybani, MD; Meghan Lubner, MD; Christine Menias, MD; Sanjeev Bhalla, MD**, "Taking stalk: imaging and management of polyps in 2010."  
—MAGNA CUM LAUDE AWARD

**Meghan Lubner, MD; Marissa Simard, MD; Christine Peterson, MD; Sanjeev Bhalla, MD; Perry Pickhardt, MD; Christine Menias, MD**, "Twist and shout: spectrum of non-bowel torsion."  
—CUM LAUDE AWARD

**Meghan Lubner, MD; Louis Hinshaw, MD; Nael Saad, MBBCh; Christine Menias, MD; Prasad Dalvie, MD; Christopher Brace, PhD; Fred Lee, MD**, "Postprocedural imaging of liver-directed therapy."  
—CERTIFICATE OF MERIT AWARD

**Rex Parker, MD; Clinton Jokerst, MD; Vincent Mellnick, MD; Constantine Raptis, MD; Sanjeev Bhalla, MD; Jonathan Baker, MD; Katie Vo, MD**, "eMeRgencies: MR imaging of emergent conditions."  
—CERTIFICATE OF MERIT AWARD

**Rex Parker, MD; Kathryn Fowler, MD; Seth Cardall, MD; Angela Tai, MD; Constantine Raptis, MD; Christine Menias, MD; Vamsi Narra, MD**, "Thinking outside the appendix: MR imaging of the acute abdomen in pregnancy."  
—CERTIFICATE OF MERIT AWARD

**Rex Parker, MD; Christine Menias, MD; Angela Tai, MD; Kumaresan Sandrasegaran, MD; Michael Friedman, MD; Vamsi Narra, MD**, "Lost and found: MR imaging findings of ectopic pregnancy."  
—CERTIFICATE OF MERIT AWARD

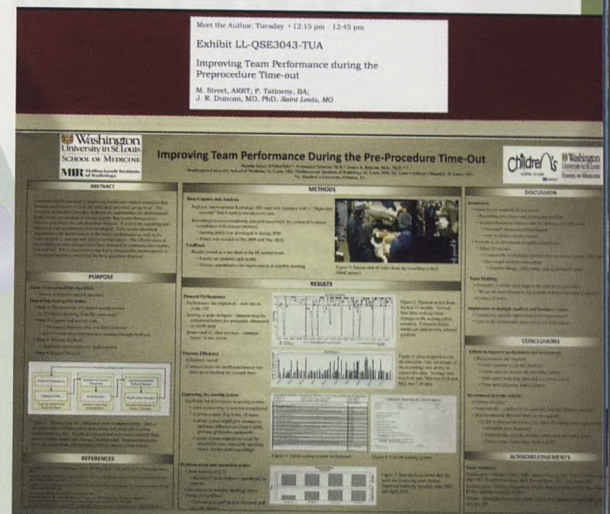
**Kartikeya Kantawala, MD, DMRD; Sushilkumar Sonavane, MD; Christine Menias, MD**, "Beyond reflux esophagitis: radiologic interpretation of strictures of the esophagus."  
—CERTIFICATE OF MERIT AWARD

**Constantine Raptis, MD; Demetrios Raptis; Kathryn Fowler, MD; Travis Henry, MD; Christine Menias, MD; Sanjeev Bhalla, MD**, "Pseu-Pseu-Pseudo! Pseudolesions of the chest, abdomen, and pelvis."  
—CERTIFICATE OF MERIT AWARD

**Meghan Lubner, MD; Leslie Johnson, MD; Tabassum Kennedy, MD; Lindell Gentry, MD; Perry Pickhardt, MD; Sanjeev Bhalla, MD; Christine Menias, MD**, "Paragangliomas from head to toe: imaging and pathologic findings."  
—CERTIFICATE OF MERIT AWARD

**Clinton Jokerst, MD; Frank Yu; Sara Dyrstat, MD; Michelle Miller-Thomas, MD**, "MR imaging findings in glioblastoma treated with bevacizumab."  
—CERTIFICATE OF MERIT AWARD

**Jason Stephenson, MD; Michael Holcomb, MD; Jonathan Baker, MD; Daniel Wessell, MD, PhD**, "Operative management of common adult acquired foot deformities: surgical procedures and postoperative imaging evaluation."  
—CERTIFICATE OF MERIT AWARD



**Carlos Restrepo, MD; Steven Bailey, MD; Eric Kumara; Fernando Gutierrez, MD; Jorge Lopata, MD; Santiago Martinez-Jimenez, MD; Rajeev Suri, MD**, "Pulmonary artery stents: imaging overview."  
—CERTIFICATE OF MERIT AWARD

**Carlos Restrepo, MD; Santiago-Martinez-Jimenez, MD; Fernando Gutierrez, MD; Felipe Munera, MD; Terry Bauch, MD; Michael McCarthy, MD**, "Cardiac trauma: the role of imaging in diagnosis and patient care."  
—CERTIFICATE OF MERIT AWARD

**Steven Don, MD; Bruce Whiting, PhD; Lois Rutz, MS; Bruce Apgar, MS**, "New digital radiography standards simplified for radiologists and technologists."  
—CERTIFICATE OF MERIT AWARD

**Geetika Khanna, MD; Kristopher Cummings, MD; Gautam Singh, MD; Sanjeev Bhalla, MD**, "Complications of the Fontan circulation: a review based on 40 cases with a failing Fontan circuit."  
—CERTIFICATE OF MERIT AWARD

**Christine Menias, MD; Kartikeya Kantawala, MD, DMRD; Sushilkumar Sonavane, MD; Khaled Elsayes, MD**, "Complications of gallstones: the Mirizzi syndrome, gallstone ileus, Bouveret syndrome, gallstone pancreatitis, and complications of 'lost' gallstones."  
—CERTIFICATE OF MERIT AWARD

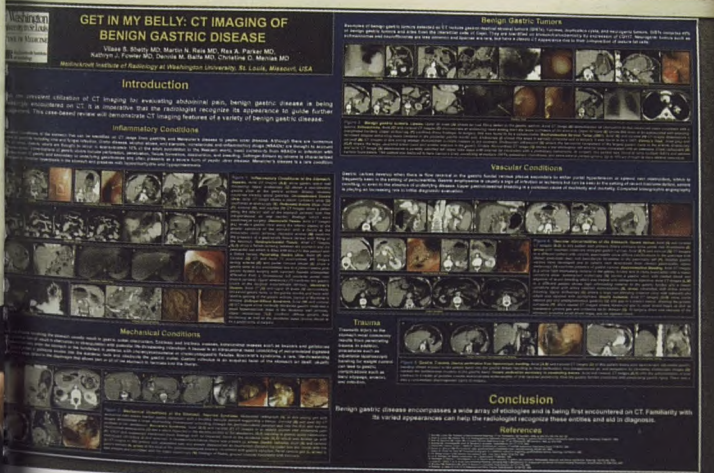
**Alexander Ho, MD; Mittul Gulati, MD; Ting Tao, MD, PhD; Christine Menias, MD**, "Uncommon autoimmune diseases of the abdomen and pelvis: You mean it's not inflammatory bowel disease (IBD)?"  
—CERTIFICATE OF MERIT AWARD

**Srinivas Peddi, MD; Cade McDowell, MD; Jennifer Demertzis, MD**, "MR imaging of injuries in the overhead throwing athlete."  
—CERTIFICATE OF MERIT AWARD

Exhibit LL-GIE3195

Get in My Belly: CT Imaging of Benign Gastric Disease

V. Illiarty, MD, Saint Louis, MO; R.A. Parker, MD, M. Reis, MD, C. G. Menias, MD; D. M. Hall, MD, E. J. Fowler, MD







# RSNA 2010

## EDUCATION EXHIBITS AND SCIENTIFIC POSTERS *continued*

**Kartikeya Kantawala, MD, DMRD; Geetika Khanna, MD; Rebecca Hulett-Bowling, MD; Martin Keller, MD,** "Cross-sectional imaging of blunt abdominal trauma in children: an interactive case-based review."

**Nichols Rhodes, MD; Jonathan Baker, MD; Daniel Wessell, MD, PhD; Christine Menias, MD; Sanjeev Bhalla, MD,** "Bone outside the bone: the spectrum of extraskelatal ossification."

**Kristopher Cummings, MD; Laura Heyneman, MD; Satinder Singh, MD; Narinder Paul, MD; Scott Nagle, MD, PhD; Joseph Azok, MD; Sharon D'Souza, MD; Sanjeev Bhalla, MD; Constantine Raptis, MD; Pamela Woodard, MD; Kok Tan, MD; Hrudaya Nath, MD; Jubal Watts, MD; Salman Allana, MD; Laura Juan, MD; Susan James, MD; Djeven Deva, MBBCh; Jon Keevil; Vikramjit Chhokar, MD,** "Cardiac case of the day."



**Pamela Woodard, MD; Stephan Achenbach, MD**

**Juan Lozano, MD; Felipe Munera, MD; Stephen Anderson, MD; Christine Menias, MD; Jorge Soto, MD; Kim Caban, MD,** "Penetrating wounds to the torso: evaluation with triple-contrast 64-slice multi-detector CT."

**Christine Menias, MD; Sushilkumar Sonavane, MD; Kartikeya Kantawala, MD, DMRD; Kumaresan Sandrasegaran, MD; Alampady Shanbhogue, MD, MBBS; Srinivasa Prasad, MD,** "Bariatric emergencies for the non-gastrointestinal radiologists: complications of laparoscopic gastric banding."

**Vincent Mellnick, MD; Rex Parker, MD; Travis Henry, MD; Sanjeev Bhalla, MD; Christine Menias, MD,** "Imaging an epidemic: a pictorial review of obesity and associated conditions."

**Alampady Shanbhogue, MD, MBBS; Raghunadan Vikram, MBBS; Venkata Katabathina, MD; Naoki Takahashi, MD; Christine Menias, MD; Srinivasa Prasad, MD,** "Genotype-phenotype taxonomy of hepatocellular adenomas: 2010 update."

**Venkateswar Surabhi, MBBS; Heng-Hsiao Liu, MD; Alampady Shanbhogue, MD, MBBS; Christine Menias, MD; Srinivasa Prasad, MD,** "Cocaine-induced abdominal catastrophes: imaging spectrum."

**Venkateswar Surabhi, MBBS; Heng-Hsiao Liu, MD; Alampady Shanbhogue, MD, MBBS; Christine Menias, MD; Srinivasa Prasad, MD,** "Primary and unusual abdominal wall hernias: imaging spectrum."

**Kumaresan Sandrasegaran, MD; Christine Menias, MD; Alampady Shanbhogue, MD, MBBS; Mark Frank, MD; Temel Tirkes, MD; Mark Tann, MD; Aashish Patel, MD; Srinivasa Prasad, MD,** "Findings in upper GI fluoroscopy examinations."

**Kumaresan Sandrasegaran, MD; Chandana Lall, MD; Aashish Patel, MD; Sadhna Verma, MD; Christine Menias, MD; Alampady Shanbhogue, MD, MBBS; Srinivasa Prasad, MD; William Berry, MD,** "Orthotopic liver transplantation: the critical first 72 hours."

**Kumaresan Sandrasegaran, MD; Thomas Howard; Pratheeshaa Nageswaran; Chandana Lall, MD; Christine Menias, MD; Mark Tann, MD; Aashish Patel, MD,** "What the oncologist and surgeon want to know in pancreatic carcinoma."

**Vilaas Shetty, MD; Rex Parker, MD; Martin Reis, MD; Christine Menias, MD; Dennis Balfe, MD; Kathryn Fowler, MD,** "Get in my belly: CT imaging of benign gastric disease."

**Stacy O'Connor, MD; Perry Pickhardt, MD; Sanjeev Bhalla, MD; Meghan Lubner, MD; Kathryn Fowler, MD; Christine Menias, MD,** "Liver enzymes: a radiologist's guide."

**Kumaresan Sandrasegaran, MD; Hans Mouser, MD; Christine Menias, MD; Temel Tirkes, MD; Alampady Shanbhogue, MD, MBBS; Srinivasa Prasad, MD; Sadhna Verma, MD; Chandana Lall, MD; Mark Frank, MD,** "So you think you are an expert on scrotal sonography?"

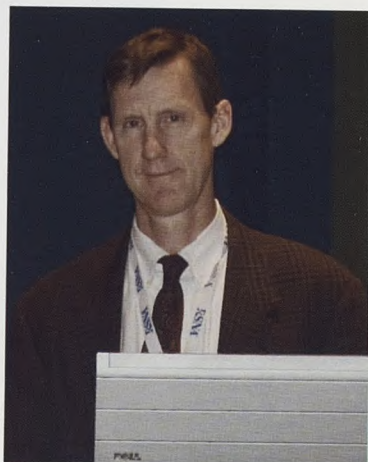
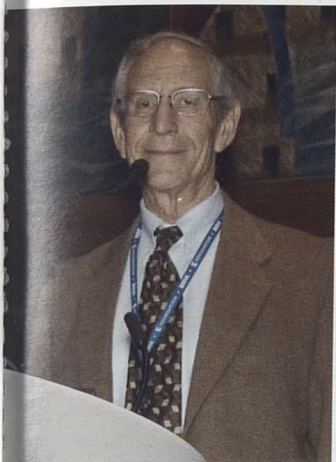
**Meghan Lubner, MD; James Hanson, MD; Orhan Ozkan, MD; Nael Saad, MBBCh; Christine Menias, MD,** "Vascular complications of solid organ transplant in the abdomen and pelvis."

**Mittul Gulati, MD; Alexander Ho, MD; Steven Sauk, MD; Cary Siegel, MD,** "Sometimes they come back—imaging of primary renal cell carcinoma subtypes correlated with patterns of recurrence and metastasis."

**Timothy Olsen, MS; John Paulett, MS; Kevin Archie; Mohana Ramaratnam; Daniel Marcus, PhD,** "The XNAT imaging informatics platform."

**Daniel Marcus, PhD; John Paulett, MD; Timothy Olsen, MS; Jenny Gurney, MS; Kevin Archie; Mohana Ramaratnam,** "An institution-wide informatics environment for managing imaging-based clinical research."





Top, left: Louis Gilula, MD  
Top, right: Colin Derdeyn, MD

**Mikhail Milchenko, PhD; Daniel Marcus, PhD**, "XNAT Desktop (XND): an open source tool for organizing and sharing research imaging data."

**Abhijit Sunnapwar, MD; Rashmi Katre, MD; Shaile Chaudhary, MD; Arpit Nagar, MBBS; Ashish Wasnik, MD; Sushilkumar Sonavane, MD**, "Value of MR imaging in duodenal imaging."

#### INFORMATICS

**Lawrence Tarbox, PhD; Patric Ljung, PhD; Gianluca Paladini, BENG**, "Rapid application development with XIP™—the eXtensible Imaging Platform."

#### MULTISESSION COURSES

**William Morrison, MD; David Rubin, MD; Lawrence White, MD**, "Case-based review of magnetic resonance: musculoskeletal—lower extremity (in conjunction with the International Society for Magnetic Resonance in medicine)."

## OF NOTE

#### RSNA Research Resident Grant

**Joseph Ippolito, MD, PhD**—  
High throughput RNA interference and pharmaceutical screens of GABA metabolism in prostate cancer hypoxia

#### Research Medical Student Grant

**Yuan Rao, BS (Eng), WUSM**—  
Comparison and correlation of FDG-PET and T2-FS MRI in the assessment of cervical cancer

Mentor: Perry Grigsby, MD, MBA

**Sanjeev Bhalla, MD**, "Coronary artery anomalies."

**Pamela Woodard, MD**, "Cardiovascular molecular imaging: update 2010."

**Christine Menias, MD**, "Malignant lesions (including gallbladder carcinoma)."

**Marilyn Siegel, MD; Jill Jacobs, MD; Shawn Teague, MD; Richard White, MD**, "Read cases with the experts (an interactive session)."

**Christine Menias, MD**, "Multimodality imaging of acute and nonacute gynecologic conditions (How-to workshop)."

**Jay Heiken, MD**, "Update course in diagnostic radiology: gastrointestinal—acute abdomen (an interactive session). Vascular compromise and bowel obstruction."

**Sanjeev Bhalla, MD**, "Pulmonary embolism and pulmonary arterial hypertension: concepts and controversies (an interactive session)."

**Suresh Vedantham, MD; Alan Matsumoto, MD; Nael Saad, MBBCh**, "Venous thrombosis: diagnosis and treatment."

**Kristopher Cummings, MD; Fernando Gutierrez, MD; Carlos Restrepo, MD**, "Multidetector CT and MR imaging evaluation of congenital thoracic disease in the adult (non-cardiac) (How-to-workshop)."

#### QUALITY STORYBOARDS

**James Duncan, MD, PhD; Mandie Street, ARRT**; Prathusha Tatineny, "Improving team performance during the procedure time-out."

**James Duncan, MD, PhD; Mandie Street, ARRT**, "Strategies for preventing catheter-associated bloodstream infections."

**Robert McKinstry, MD, PhD; Ronald Evens, MD; Sreevathsan Sridhar; Stephen Currie; Emily Beck; Mandie Street, ARRT; James Duncan, MD, PhD**, "Optimizing radiation use during computed tomography and fluoroscopy."

#### REFRESHER COURSES

**Daniel Wessell, MD, PhD; Travis Hillen, MD; Jeffrey Peterson, MD; Robert Lopez-Ben, MD**, "Musculoskeletal bone biopsy: an interactive session (How-to workshop)."

**Marilyn Siegel, MD**, "Practical pediatric vascular imaging (an interactive session): CT imaging."

**Dennis Balfe, MD**, "Current activities of the American Board of Radiology (in conjunction with the American Board of Radiology)."

**Pamela Woodard, MD; Vincent Ho, MD, MBA**, "Cardiac CT mentored case review: part I (in conjunction with the North American Society for Cardiac Imaging)."

**Sharlene Teefey, MD**, "Some great cases I have seen: scrotum, thyroid, and gallbladder (an interactive session). Scrotum."

**Nirvikar Dahiya, MD**, "Some great cases I have seen: scrotum, thyroid, and gallbladder (an interactive session). Thyroid."

**Pamela Woodard, MD**, "Current status of coronary artery imaging: reimbursement issues."

**Geetika Khanna, MD; Santiago Medina, MD; Aseem Sharma, MBBS**, "Pediatric spine: an interactive review of scoliosis and dysraphism (How-to workshop)."



Nirvikar Dahiya, MD

**Sanjeev Bhalla, MD**, "Knives and guns: imaging penetrating trauma—thorax."

**Christine Menias, MD**, "Knives and guns: imaging penetrating trauma—abdomen."





# RSNA 2010

## REFRESHER COURSES *continued*

**Cylen Javidan-Nejad, MD; Carol Langford, MD, MHS; Tan Lucien Mohammed, MD; Aletta Frazier, MD,** "CT and MR imaging of thoracic vasculitides (How-to workshop)."

## SCIENTIFIC SESSIONS



James Duncan, MD, PhD

**Laura Fayad, MD; David Rubin, MD,** "Musculoskeletal (Quantitative imaging)."

**Regina Beets-Tan, MD; Laura Carucci, MD; Sharlene Teefey, MD,** "ISP: gastrointestinal (rectal cancer: advanced imaging)."

**James Duncan, MD, PhD,** "Showcase of quality improvement projects: Introduction to quality showcase."

**James Duncan, MD, PhD,** "Showcase of quality improvement projects: Improving team performance during the procedure time-out."

**Hajime Sakuma, MD; Cylen Javidan-Nejad, MD; Bernd Wintersperger, MD,** "Cardiac (cardiac MR imaging: coronary anatomy and myocardium)."

**Lisa Rohrer, MA; Soe Mar; Joshua Shimony, MD, PhD; Abraham Snyder, MD, PhD; Tammie Benzinger, MD, PhD,** "Neuroradiology/head and neck (white matter and diffusion): radial and axial diffusivity correlates of leukodystrophy type and severity."

**Louis Gilula, MD,** "Interventional musculoskeletal pain and tumor treatment: Does vertebroplasty improve health-related quality of life?"

**Gautham Reddy, MD; Richard White, MD; Pamela Woodard, MD,** "Cardiac (CT/MR imaging: left atrium before and after ablation)."

**Suhny Abbara, MD; Kent Yucel, MD; Andrew Bierhals, MD,** "Cardiac (CT/MR imaging: cardiomyopathies II)."

**Lina Nayak; Suresh Vedantham, MD,** "Vascular/interventional (a day in the life of an interventional radiologist)—Post-thrombotic syndrome: early outcomes of imaging-guided endovascular."

**Jie Luo, MS; Anne Cross, MD; Pascal Sati, Dipl Eng, PhD; Dmitriy Yablonskiy, PhD,** "Quantitative monitoring of the multiple sclerosis progression using gradient echo plural contrast imaging technique."

**Richard Brown, MD; Yusuf Menda, MD; Bennett Greenspan, MD,** "Nuclear medicine (oncology: PET)."

**Richard Duszak, MD; Robert Optican, MD; Pamela Woodard, MD,** "Utilization and coverage of cardiac CT and coronary CTA: early Medicare claims experience."

Right: Stephen Moore, MS

**Susan Holley, MD, PhD; Catherine Appleton, MD; Valerie Reichert, MD; Dione Farria, MD; Charles Hildebolt, DDS, PhD; Craig Allred, MD,** "Pathologic outcomes of papillary breast lesions diagnosed by imaging-guided percutaneous core needle biopsy."


**Bayne Selby, MD; Steven Dymarkowski, MD; Andrew Bierhals, MD,** "Cardiac (CT/MR imaging: left ventricular anatomy and function)."

**Jared Allen, MD, PhD; Seth Cardall, MD; Mayuree Kittijarukhajorn, MD; Cary Siegel, MD,** "Genitourinary (benign gynecologic conditions and pregnancy)—Ovarian maldescent in women with Mullerian duct anomalies: evaluation by pelvic MRI."

**Geetika Khanna, MD; Nancy Rosen, MD; James Anderson, PhD; Peter Ehrlich; Douglas Barnhart; Kenneth Gow; Paul Grundy, MD,** "Pediatrics (general)—Evaluation of diagnostic performance of CT for detection of tumor thrombus in children with Wilms tumor: a report from the Children's Oncology Group."

## SPECIAL PRESENTATIONS

**Ann Leung, MD; Henry Royal, MD; Lynne Hurwitz, MD; Helen Winer-Muran, MD; Phillip Boiselle, MD,** "Imaging the pregnant patient for pulmonary embolism."

**Pamela Woodard, MD,** "Coronary CT angiography: Should it be part of clinical practice?" 

## RSNA 2010 MEETING FACTS


- 60,000 international medical – and science – professional attendees
- 4,200 scientific papers, posters, and education exhibits
- 700+ technical exhibits
- 300+ refresher courses

**Colin Derdeyn, MD,** "Neuroradiology (interventional)."

**Pamela Woodard, MD; Cylen Javidan-Nejad, MD; Bayne Selby, MD,** "Cardiac (CT/MR imaging: quantitative techniques)."







The Annual  
**MIR**  
Reception at  
**RSNA 2010**

NOVEMBER 29, 2010  
CHICAGO CULTURAL CENTER



Above: Vamsi Narra, MD, and (right) David Kim, MD



Anil Khosla, MD, and (right) Aseem Sharma, MD



Above: (left to right) Otha Linton, MSJ; Clark West, MD; and Ronald Evens, MD



Above: (left to right) Russell Allman, MD; Paul Holcombe, MD; Vilaas Shetty, MD; Joanna Allman

Right: Scott Mirowitz, MD and (right) Gary Brink, RT, BS



Above: Sandy Ruhs, MD; David Ruhs; Dennis Balfe, MD

Left: Perry Pickhardt, MD, and (right) Gilbert Jost, MD





# A LINC TO THE HISTORY OF PERSONAL COMPUTING

**On November 5, 2010**, a group of graying computer scientists gathered at the School of Medicine's Bernard Becker Medical Library for the launch of an exhibit that brought back happy memories for them – and illuminated for the crowd an overlooked piece of computing history, tied closely to Washington University. At the heart of the exhibit is a pioneering piece of equipment: a Laboratory Instrument Computer (LINC), along with an interactive display that traces the nearly 40-year history of LINC, which many regard as the first personal computer.

by Candace O'Connor

Above: William Powers, MD, with the LINC used in radiation treatment planning at Washington University School of Medicine.



**T**

his gathering was a nostalgic event," said Gilbert Jost, MD, professor of radiology and director of Mallinckrodt Institute of Radiology. "It gave us a chance to think back on the remarkable accomplishments of some talented individuals who, for a time, established Washington University as one of the most important centers in the world for using computers to solve biomedical problems."

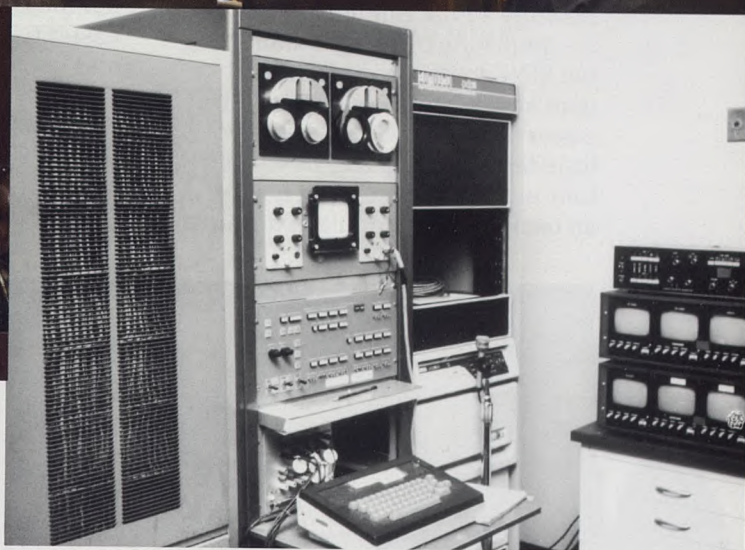
Among the crowd were some of the LINC's developers. One was Wesley Clark, the Massachusetts Institute of Technology (MIT) researcher who created the LINC at MIT's Lincoln Laboratory with his late colleague, Charles Molnar. Another was Mary Allen Wilkes, who wrote LINC's interactive operating system. Still others were computer pioneer Severo Ornstein, who has written a book describing the LINC's development, and LINC veterans Maury Pepper, Gerald Johns, and Tom Chaney who have worked in recent years with colleague Scott Robinson on LINC reconstructions.

Also present was a key member of the LINC team: Jerome Cox, DSc, professor of radiology from 1986-98 and currently senior professor in the Department of Computer Science and Engineering at Washington University. In 1963, he was appointed to a LINC Evaluation Board that chose teams to test the LINC's usefulness in lab research. Recognizing the device's potential, he persuaded a Washington University researcher to apply for—and win—one of the first LINC's.



**Top: Jerome Cox, DSc (at podium), the driving force behind the LINC display**

**Above: Mary Allen Wilkes, speaking at the LINC exhibit launch.**



**LINC. Circa early 1970s.**

**"THE LINC DEMONSTRATED THAT A COMPUTER COULD BE USED AND MANAGED BY A SINGLE PERSON."**

Then in 1964, Cox convinced Washington University to recruit the LINC's 20-member group to campus. After the move, they focused on further LINC development and also helped faculty members make biomedical discoveries. Versatile and powerful in its time, yet accessible to nonspecialists, LINC enabled significant research advances to be made.

"The LINC demonstrated that a computer could be used and managed by a single person," says Cox. "Researchers could write their own programs, interface the machine to their lab equipment, control experiments and analyze results. This seems commonplace today, but forty-nine years ago it was unique."



# A LINC TO THE HISTORY OF PERSONAL COMPUTING

## THE LINC: PIONEERING TECHNOLOGY

The LINC on display at Becker Library is a reconstruction, with many parts from an original LINC owned by the University of Wisconsin and some parts from other LINC's once owned by Washington University. Over a period of months, the veteran team of Johns, Pepper, and Robinson pieced the computer together with painstaking care in a basement room of Mallinckrodt Institute's East Building.

Imposing by today's standards, the LINC in its day was smaller than any existing computer and easier to use. Taking relatively little laboratory space, LINC had four modules: a control console, an oscilloscope module, a terminal

In 1962, when the MIT group developed LINC, they were working within a computing world dominated by huge IBM systems, ill-suited to laboratory use. These giant machines were operated by specialists, who ran programs for a range of researchers.

But Wesley Clark and others held a dissenting view: the end users needed direct access to computers, which should become pieces of lab equipment. Thus, computers should be smaller, easier to program and maintain and less expensive.

computer," says Clark today. "I had no expectation whatsoever that the LINC would have any 'lasting significance' to computing. I hoped only to jump-start brain research, at least, by providing it with a soundly designed and engineered counter-example that would put it ahead of the game."

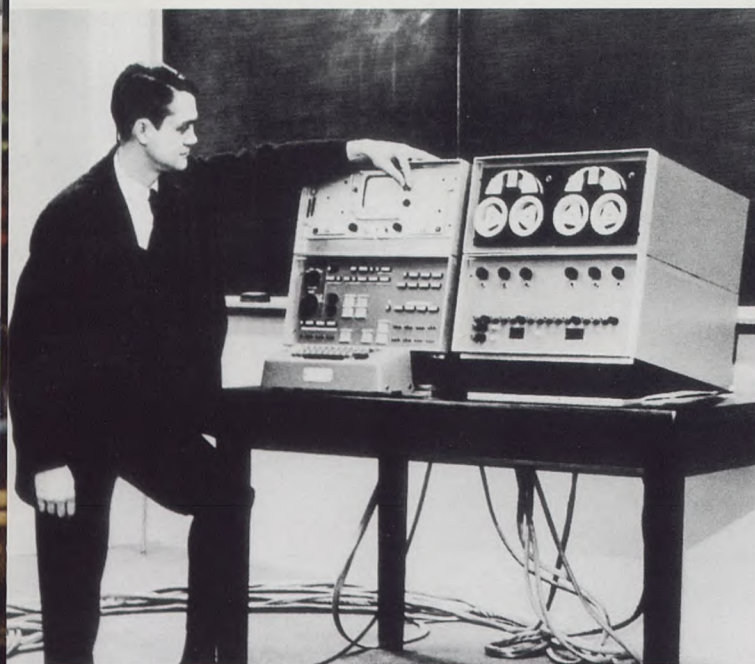
With the staunch support of his Lincoln Lab boss, William Papian, Clark built a prototype device using modules supplied by Digital Equipment Corporation (DEC), founded by a former Lincoln Lab staff member, Kenneth

Olsen. With Charlie Molnar, Clark took this machine to the National Institutes of Health (NIH), then eager for new ways to use computers in biomedical research. After seeing the LINC, the NIH awarded Clark and Molnar \$1.5 million in development funds.

## COMPETING FOR THE LINC

In 1963, the NIH appointed its LINC evaluation

board, which included Cox. They publicized an irresistible deal: In exchange for coming to Boston to learn the LINC's operation and agreeing to critique its usefulness, biomedical researchers could have a LINC for their own use. From 72 applicants, Washington University neurosurgeon Sidney Goldring, MD, was chosen as one of the 12 winners. Eventually, Goldring would use his LINC to do groundbreaking work in the neurosurgical



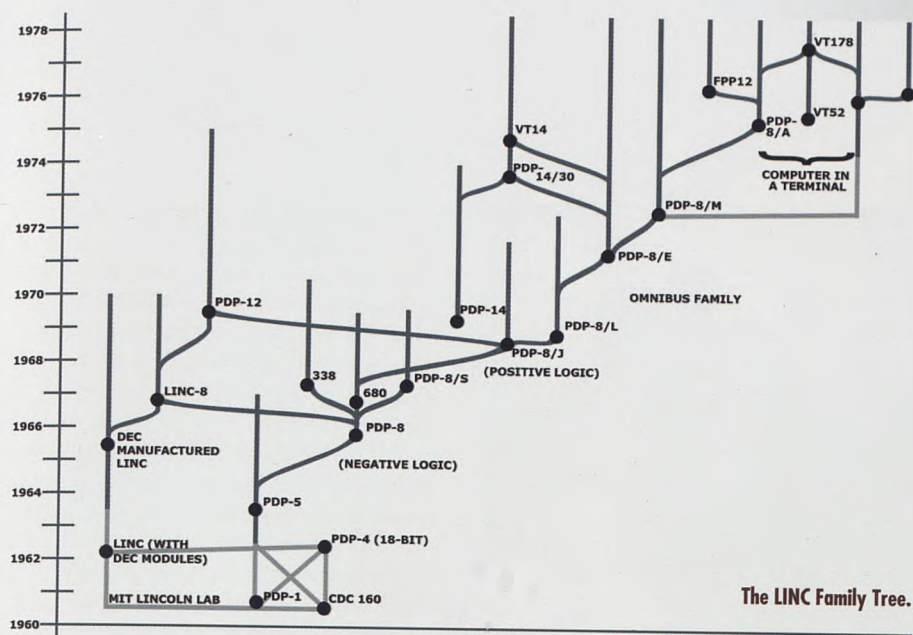
Left: Wesley Clark with components of the first LINC. Circa early 1960s.

Top, right: William Danforth, MD, chancellor emeritus, unveiled a commemorative plaque for the LINC exhibit.

module that could connect to specialized lab equipment, and the LINC tape module that stored data and programs. Its small, reliable tape drive was its most important innovation—an ancestor of later floppy disks.

"It was my growing realization that, in particular, biological research was being given such short shrift that led me to undertake the design of a suitable laboratory instrument





The LINC Family Tree.

operating room, recording the brain waves of patients undergoing surgery.

Meanwhile, Cox had received a grant to build a computer for the physiology laboratory at the Central Institute for the Deaf, and he decided to visit DEC to see what modules were available.

After a conversation with Olsen, Cox went to Lincoln Lab, met with Clark, and saw the LINC prototype.

## THE END USERS NEEDED DIRECT ACCESS TO COMPUTERS, WHICH SHOULD BECOME PIECES OF LAB EQUIPMENT.

Quickly, “I realized that there was absolutely no point in trying to build something that was different from the LINC,” said Cox in a 2006 oral history. “Wes was clearly well ahead of my thoughts and had a successful prototype already that did everything that I thought about doing and more. So I joined forces with Wes Clark and his team.”

Hearing that the LINC team had encountered political problems at MIT, Cox, who founded the Biomedical Computer Laboratory (BCL) at Washington University in 1964, urged then Provost George Pake to recruit the LINC group. Pake was successful, and the group arrived in July 1964. They established the Computer Research Laboratory (CRL) under Papan; later, under Clark, it was renamed the Computer Systems Laboratory (CSL).

### THE LINC'S ACHIEVEMENTS

While the BCL applied computer techniques to problems in biology and medicine, the CSL focused on the LINC evaluation

and “macromodules,” a system for creating complex computer systems. In 1984, the CSL and BCL were combined in the new Institute for Biomedical Computing, a joint venture of Washington University’s engineering and medical schools. Under Molnar, it did advanced work in biomedical sciences, before ceasing operation in the 1990s.

Eventually, the LINC was superseded by new generations of computers, but during its lifetime it had a remarkable impact. At Washington University, researchers used their LINC—ten that eventually came to campus—on auditory applications: generating precise sounds, recording responses, and displaying data faster than ever before. Tom Goblick and Russell Pfeiffer, Department of Physiology researchers, developed a new understanding of nonlinear mechanisms in cochlear sensory nerves.

Left: Charles Molnar, co-creator of the LINC.  
Circa mid 1970s.





# A **LINC** TO THE HISTORY OF PERSONAL COMPUTING



**Top: LINC group at MIT's Lincoln Lab. Circa mid 1960s.**

**Left: The team of researchers who restored a LINC for display at the 10th Vintage Computer Festival in 2009: (clockwise) Jerome Cox, Gerald Johns, Tom Chaney, Scott Robinson, Maury Pepper, and Wesley Clark.**

Later, a LINC successor, the Programmed Console (PC), helped BCL create the first graphic radiation treatment planning system, which spun off to become Artronics and then CMS, one of the nation's leading companies in this field. The PC was also used with a Nuclear-Chicago

Pho/Gamma III camera to help James Potchen, MD, a nuclear medicine physician, perform the first on-line imaging study of brain activity.

In 1969, BCL scientists established the first computer monitoring of cardiac arrhythmias in the

Coronary Care Unit at Barnes Hospital in St. Louis. Later, Molnar, biochemist Garland Marshall, and computer scientist Dave Barry developed drug design algorithms that led Marshall to spin off Tripos, Inc., to create software for the pharmaceutical industry.

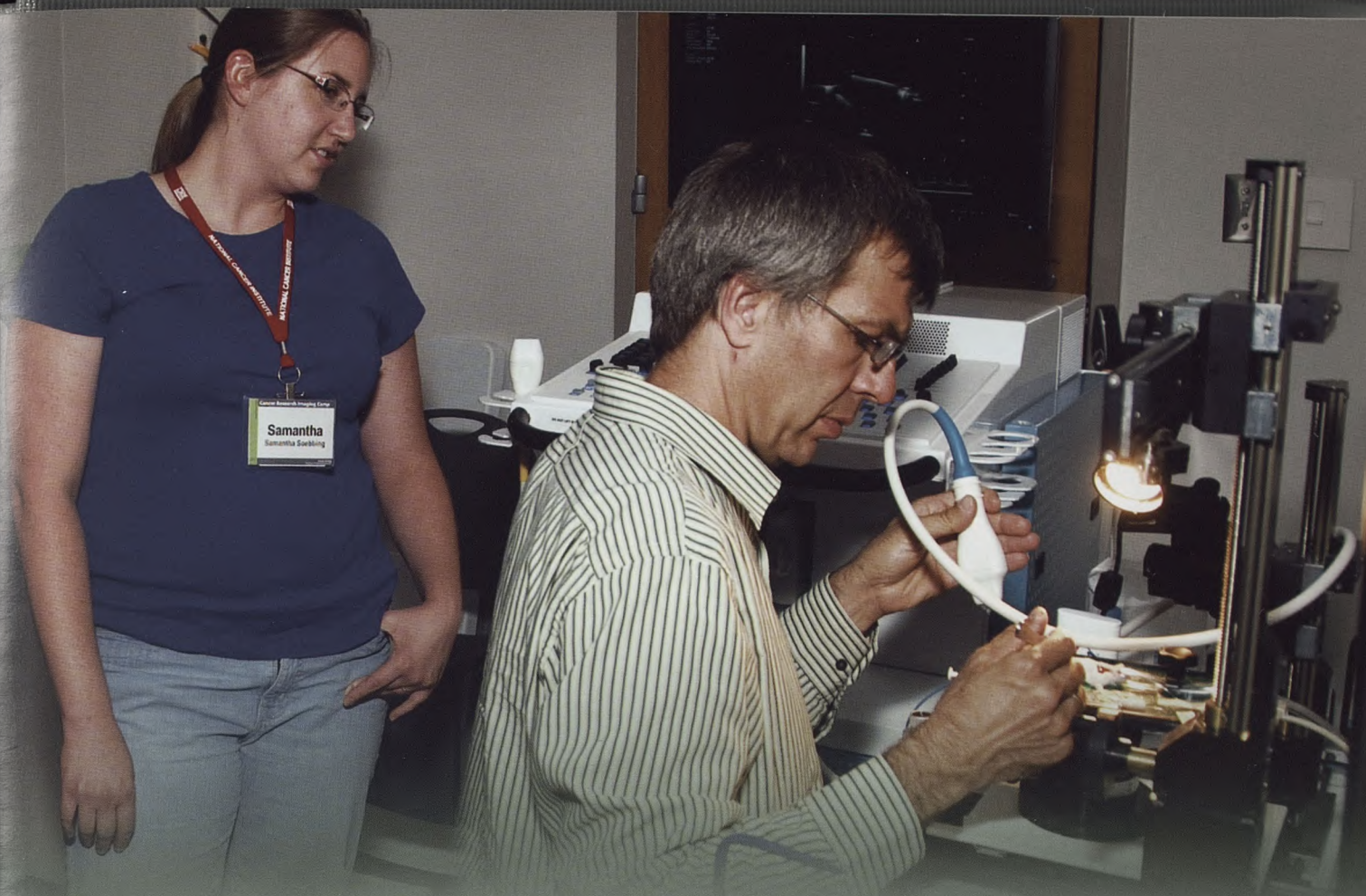
The original 12 LINC institutions, and others in years to follow, used the computer to do groundbreaking biomedical research in such fields as neurophysiology, radiology, radiation treatment planning, surgery, obstetrics/gynecology, physiology, audiology, and cardiology. At the University of Wisconsin, neurophysiologists studied the physiology of the auditory system. At Johns Hopkins University, scientists used LINC to carry out classic experiments in neurophysiology.

Altogether, the LINC helped scientists make research advances in such areas as the hydrodynamics of blood flow, fetal cardiography, epileptic neural firing, osteoporosis in the aged, biophysical properties of bone, EEG brainwave analysis, digital computer technology for the coronary care unit, studies of the cochlear nucleus, and arterial shock wave measurements.

"Other examples include the first computer-based patient interviews, the first computer-based dynamic brain images, the first computer-based monitoring of cardiac arrhythmias, and the first computer-based management of neurophysiological experiments," says Cox. "Many of today's applications of computers in biomedical research and in medicine can be traced back to the LINC and its descendants." **MR**

*The exhibit at Becker Medical Library will be on display until July 2011, when it will be moved to Washington University's Danforth campus.*





# CANCER RESEARCH IMAGING

AN EDUCATIONAL OPPORTUNITY FOR BASIC CANCER RESEARCHERS

by Vicki Kunkler

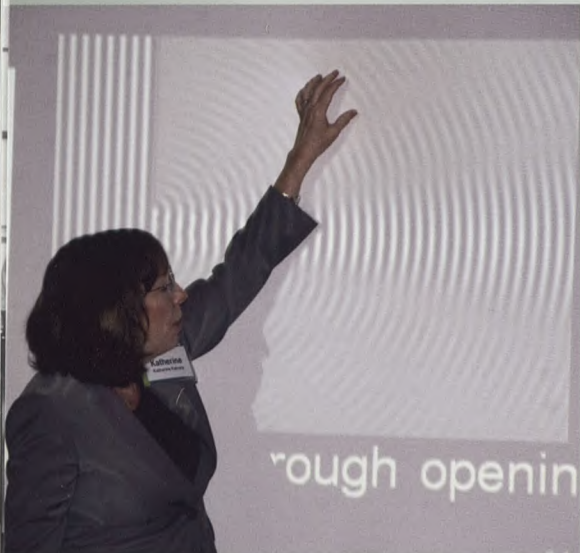
Washington University once again hosted the annual Cancer Research Imaging Camp—an intensive course on *in vivo* small animal (eg, mouse) and live cell-imaging techniques. Sponsored by the Cancer Imaging Program of the National Cancer Institute, in partnership with Siteman Cancer Center and the American Association for Cancer Research, the Imaging Camp provided lectures and hands-on lab sessions to post doctoral fellows and early career-level faculty

involved in fields related to basic cancer biology. Participants gained experience in a wide range of imaging modalities, including advanced optical imaging, computed tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET), single photon emission tomography (SPECT), and ultrasound (US). The course also provided participants with the necessary information for selecting the appropriate imaging technique to investigate a biological hypothesis and for interpreting the imaging data.

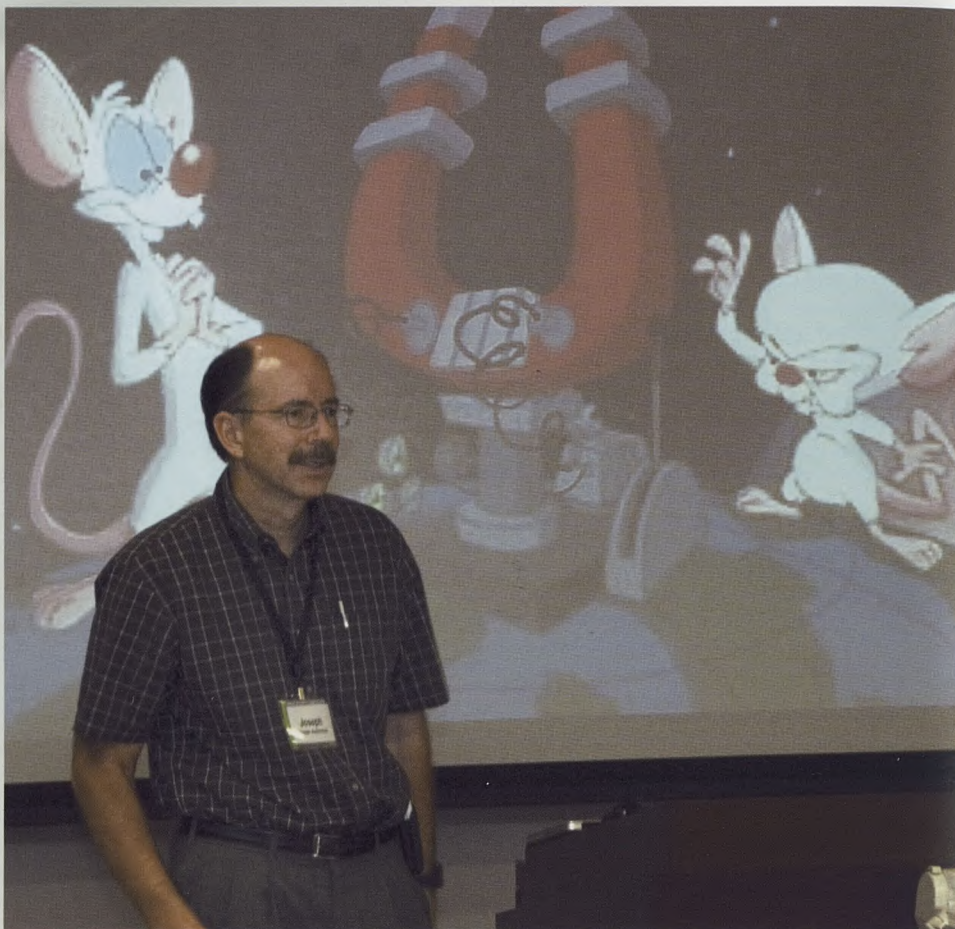
Above: (seated) Attila Kovacs, MD, associate professor of medicine



# CANCER RESEARCH IMAGING



Katherine Ferrara, PhD, University of California, Davis



Joseph Ackerman, PhD, professor of chemistry, of medicine, and of radiology

## IMAGING CAMP FACULTY

### WASHINGTON UNIVERSITY/ MALLINCKRODT INSTITUTE

- Samuel Achilefu, PhD
- Joseph Ackerman, PhD
- Walter Akers, DVM, PhD
- John Engelbach, AS
- Joel Garbow, PhD
- Attila Kovacs, MD
- Richard Laforest, PhD
- Robert Mach, PhD
- William Spees, PhD
- Lihong Wang, PhD
- Michael Welch, PhD

### OTHER INSTITUTIONS

- Cristian Badea, PhD, Duke University
- Kenneth Bielat, PhD, National Cancer Institute
- Katherine Ferrara, PhD, University of California, Davis

### OTHER INSTITUTIONS CONTINUED

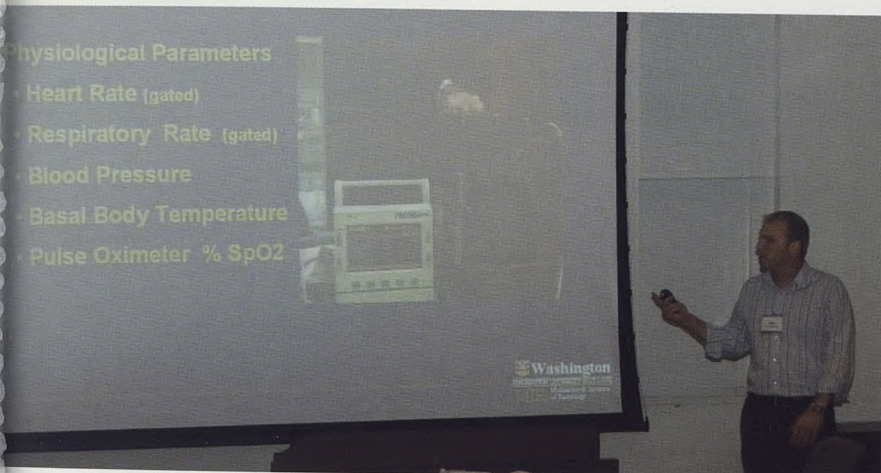
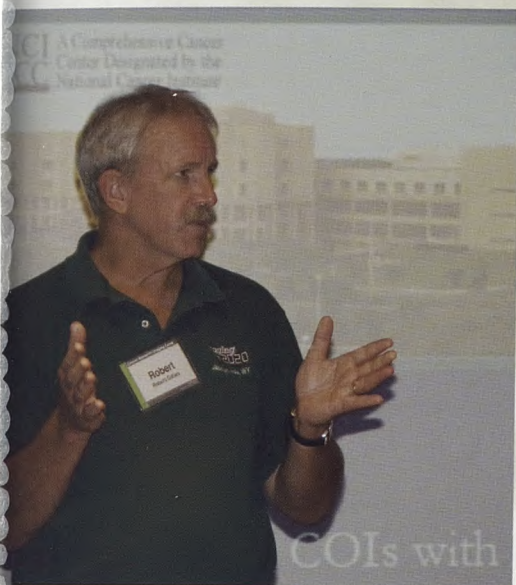
- Robert Gilles, PhD, Moffitt Cancer Center
- Kenneth Krohn, PhD, University of Washington
- Angelique Louie, PhD, University of California, Davis
- Anne Menkens, PhD, National Cancer Institute
- Sabrina Ronen, PhD, University of California, San Francisco
- Dean Sherry, PhD, University of Texas, Dallas
- Bonnie Sloane, PhD, Wayne State University
- Charles Springer, PhD, Oregon Health and Science University
- Pushpa Tandon, PhD, National Cancer Institute
- Simon Watkins, PhD, University of Pittsburgh

## SEMINARS

- **Samuel Achilefu, PhD**, "Fundamentals of optical imaging and optical probes"
- **Joseph Ackerman, PhD**, "A battle of kingdoms: Animalia (Hominidae) vs Plantae. Simple questions—elusive answers"
- **Cristean Badea, PhD**, "Fundamentals of computed tomography"
- **John Engelbach, AS**, "Animal handling and anesthesia, radiation safety"
- **Katherine Ferrara, PhD**, "Fundamentals of ultrasound physics and imaging"; "Biological applications of ultrasound"



Robert Giles, PhD, Moffitt Cancer Center



John Engelbach, AS, special procedures technologist

## SEMINARS CONTINUED

- **Joel Garbow, PhD**, "Fundamentals of magnetic resonance and MRI"
- **Robert Gilles, PhD**, "Biomarkers and radiomics"
- **Richard Laforest, PhD**, "Fundamentals of SPECT and PET"
- **Angelique Louie, PhD**, "Multimodal imaging agents"
- **Robert Mach, PhD**, "SPECT/PET imaging and probes"
- **Sabrina Ronen, PhD**, "MR spectroscopy"
- **Dean Sherry, PhD**, "MR imaging agents"
- **Charles Springer, PhD**, "Biological applications of MR"
- **Lihong Wang, PhD**, "Photoacoustic tomography"
- **Simon Watkins, PhD**, "Biological applications of optical imaging and optical probes" VIII

## CANCER IMAGING PROGRAM

The Cancer Imaging Program was established by the National Cancer Institute (NCI) in 1996 as the Diagnostic Imaging Program. The current name more clearly reflects the program's mission:

- To promote and support cancer-related basic, trans-lational, and clinical research in imaging sciences and technology.
- To promote and support the integration and application of these imaging discoveries and developments to the understanding of cancer biology and to the clinical management of cancer and cancer risk.





# Breathing easier

RESEARCH BREAKTHROUGH WILL BENEFIT PATIENTS WITH LUNG DISEASE

by Michele Munz

Helium-3 lung morphometry (a new technique developed by scientists at Washington University Medical Center for imaging the lungs with magnetic resonance imaging, or MRI), is a way to measure levels of damage to the organs' entire microstructure—starting first in the alveoli, the honeycomb-like sacs where the exchange of oxygen and carbon dioxide take place. The discovery opens the door to studies of living lungs that have never before been possible.



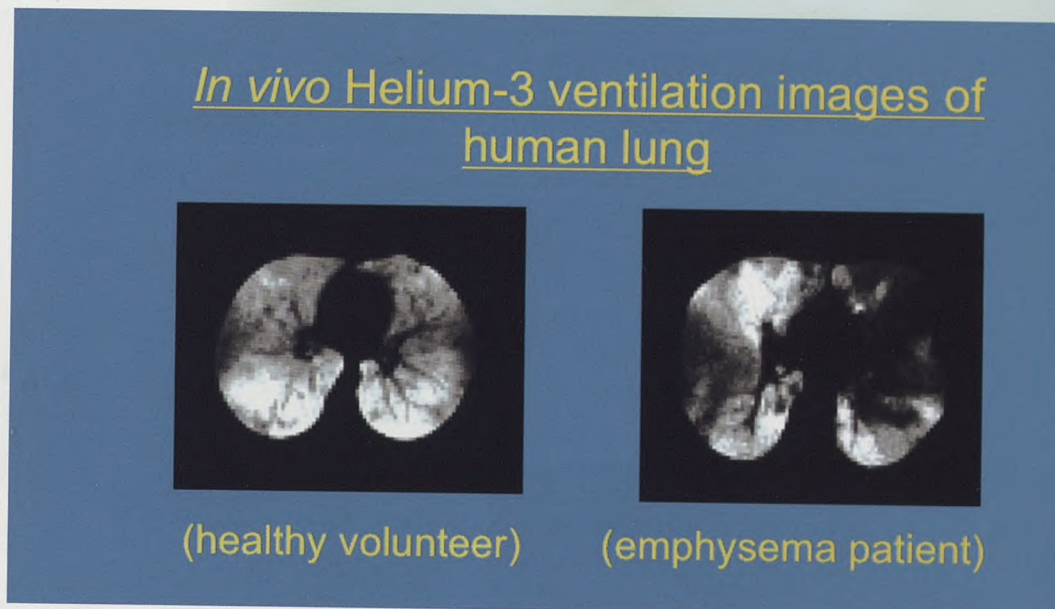
**B**ecause MRI scans produce noninvasive detailed images of the body's internal structures, they have become important diagnostic tools to detect disease within the body—except for the lungs. On diagnostic scans, an empty shadow shows up where the lungs should be.

The foam-like structure of the lungs is unlike other dense organs in the body. Lungs are mostly air and are undetectable by MRI, which picks up signals from the large amount (approximately 80 percent) of water comprising the human body. The signals are produced by what is called water's "magnetic moments."

Previously, biopsy was the only way to diagnose disease in the lungs at the alveolar level of a living person—excising a piece of the lung and studying it under a microscope. That small piece, however, doesn't show what might be happening in other parts of the lungs. Also, a biopsy can only reach about the fourth level of the nearly two dozen levels of airway branches that spread throughout the lung.

#### Solving the problem

The use of hyperpolarized gases steered scientists to the discovery of a solution to this problem. The gas Helium-3 ( $^3\text{He}$ ) is a light, nonradioactive isotope that has a magnetic moment, just like water. Physicists have figured out how to radiate the helium atoms, causing the atoms to be aligned and strongly magnetized—or "hyperpolarized." About 15 years ago, scientists at Princeton University wondered if hyperpolarized gas could be used to produce an MR image of the lungs. In a study released in 1996, they showed that having a patient inhale the benign gas and then immediately scanning the patient



by MRI could produce detailed images of the lungs. The discovery was groundbreaking, but it was just the beginning. What do the images mean? What is normal and what's not? How should doctors interpret the differences? Washington University researchers jumped at the chance to make sense of these new detailed pictures of living lungs.

"When we learned about this unique opportunity, we wanted to

#### Building the research team

Brian Saam, a Princeton University scientist who was involved with the original research and knew how to build and operate the device to hyperpolarize helium became part of the Washington University research team, which initially included Yablonskiy; Mark Conradi, PhD, professor of physics; and David Gierada, MD, professor of radiology. Also on board were Joel Cooper, MD, at that time a surgeon

“When we learned about this unique opportunity, we wanted to implement it here at Washington University”

implement it here at Washington University,” says Dmitriy Yablonskiy, PhD, professor of radiology and adjunct professor of physics. “It was a unique area of research—to look at the lungs without doing any harm to the patient and to get information not available with any other tests.”

at Washington University, who developed lung volume reduction surgery (LVRS)—the removal of only the diseased part of lungs in patients with advanced stages of emphysema, and Stephen Lefrak, MD, professor of medicine and medical director of the Lung Volume Reduction Program at Washington University medical Center. Cooper and Lefrak were interested in how



# Breathing easier

RESEARCH BREAKTHROUGH WILL BENEFIT PATIENTS WITH LUNG DISEASE

the MR image of the lung could be used to better determine which patients were eligible for LVRS.

The researchers used images taken of Cooper's patients to gain a better understanding of the new science using hyperpolarized gas. The images of the patients' lungs clearly showed which parts were able to take in oxygen and which were not. The scientists also were able to compare images taken before and after surgery, to see how the lungs improved overall.



This coil is only used with helium studies. One of the magnets in the Institute's research facility was upgraded to accommodate the use of helium.

"The first results were really striking. We could easily differentiate the ventilated part of the lungs," Yablonskiy says. "It gave us great hope that we might be able to use this technique as a very sensitive diagnostic tool."

The research team surmised that if they could study the motion of the helium atoms (how the atoms bounce around in the smallest structures inside the lungs), they could better understand the beginnings and progression of disease.

"If we could somehow measure, using MRI, this restricted movement, we could get information about the alveoli," Yablonskiy says.



Dimitriy Yablonskiy, PhD, and (right) James Quirk, PhD, research instructor in radiology, with a tank used to recycle helium.

"We likened it to a similar MRI technique called diffusion MRI that is used to detect problems in the brain by measuring water movement."

Joining the research team later was Ewald Weibel, MD, DSC, professor emeritus of anatomy at the Institute of Anatomy, University of Berne, Switzerland. Through an

extremely time-consuming study of crystallized cadaver lungs, Weibel developed the gold standard for diagnosing lung disease using measurements of their microstructure. The Washington University team used these measurements to validate their in vivo Helium-3 lung morphometry.



### Beginning the process

The first step involved looking at the diffusion of molecules in healthy lungs and developing a “diffusivity map,” which measured how far a molecule can move inside parts of the lungs. Researchers did the same thing in lungs with

“This information previously was only available when a piece of the lung was removed and then measured under a microscope. Now, we can do it in vivo in a ten-second MRI scan and obtain information from the whole lung.”

Robert Senior, MD, professor of pulmonary disease in medicine and of cell biology and physiology, is excited about the possibilities that can be applied to the research of chronic obstructive pulmonary disease (COPD): “This technology and its associated sophisticated data analysis are a brilliant and unique means of identifying lung pathology at very early stages and for quantifying small changes in lung pathology of already-diseased lungs. I see it potentially as a way to study the effects of medications and other interventions on the lungs of apparently healthy smokers and people with COPD.”

According to Lefrak, being able to measure, over time, the size of the gas exchange units in the lung is a key part of treating patients with lung disease. “This is especially important in order to follow the development and progression of

**“ This technology and its associated sophisticated data analysis are a brilliant and unique means of identifying lung pathology at very early stages...”**

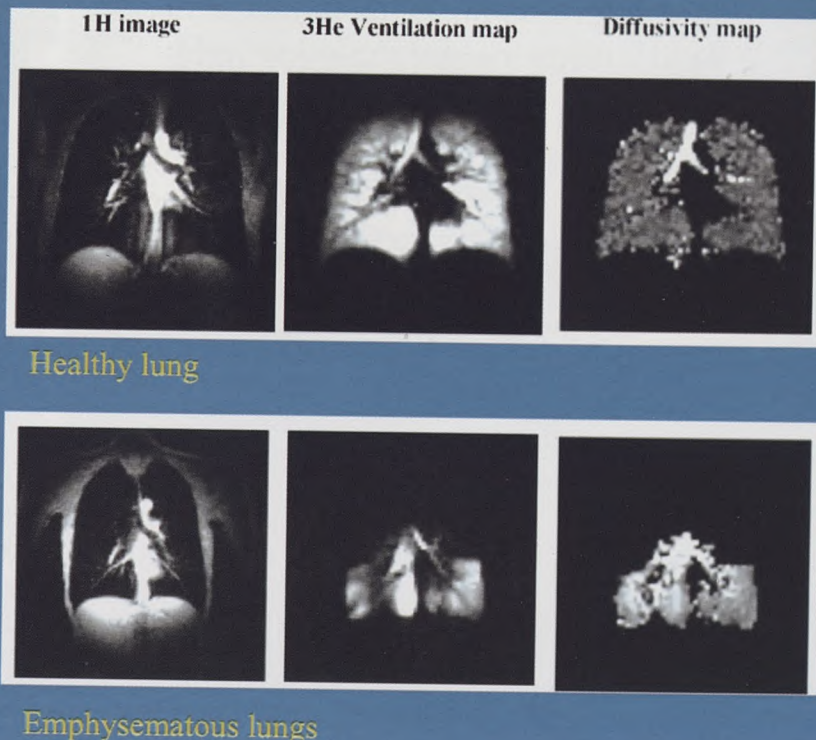
emphysema and found that in those alveoli, diffusion was three times more than that of healthy lungs. The molecules in the healthy lungs were much more restricted in their movement because of the lung’s sponge-like makeup than are damaged alveoli, which are more cavernous than sponge-like. Using these measurements and a theoretical model of Helium-3 gas diffusion in lungs (developed by Yablonskiy and Alex Sukstanskii, PhD, senior scientist in Mallinckrodt Institute’s Division of Radiological Sciences), the scientists were able to precisely quantify the difference of MRI-captured diffusion between healthy and damaged alveoli. This allowed them to determine the parameters of the alveoli, which can be used to diagnose disease.

“We developed a mathematical theory on how gases diffuse in the lungs and developed a new MRI technique to measure damage in the lungs,” Yablonskiy says.

Ventilation map in emphysema subject shows large ventilation defect—portion of the lung that is not functioning, thus the likely candidate for removal during LVRS.

### Benefits of the new science

The exciting part about <sup>3</sup>He lung morphometry: Because it is safe and well-tolerated by the patient, it can be repeated on a regular basis. That makes it a strong tool for research, clinical, and drug development studies.





# Breathing easier

RESEARCH BREAKTHROUGH WILL BENEFIT PATIENTS WITH LUNG DISEASE

emphysema in living patients without subjecting them to dangerous, invasive procedures and may be more sensitive than other readily available tests of lung function or structure.”

The possibilities of this new science are endless:

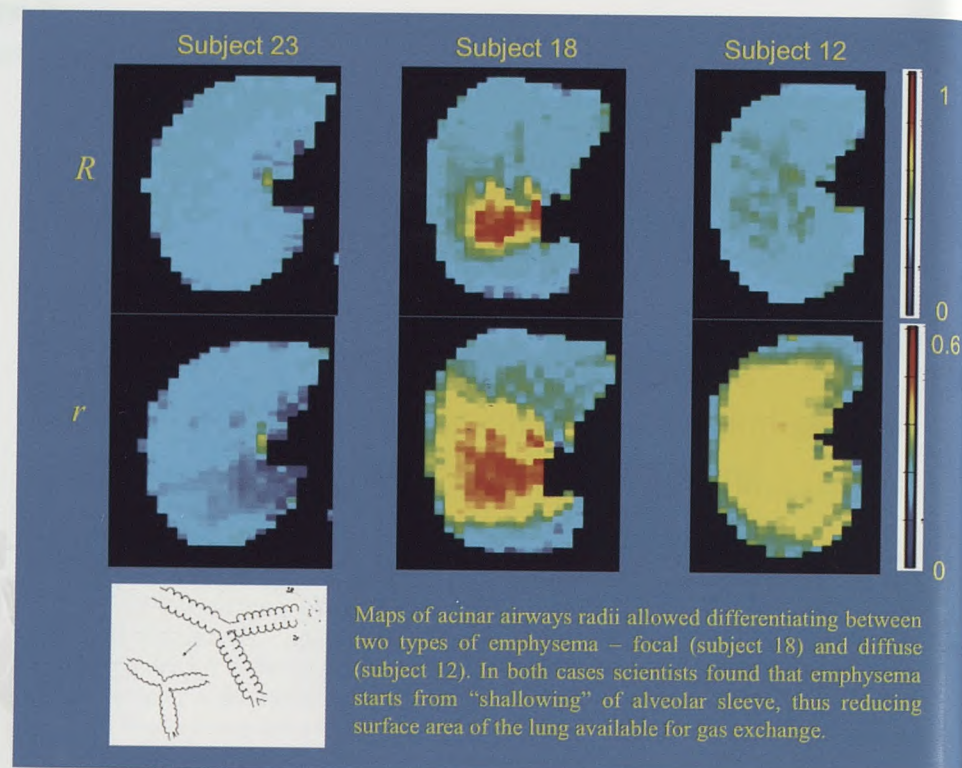
- MRI could replace less accurate pulmonary tests for diagnosing emphysema.
- Drugs could be tested to determine if they improve the condition of alveoli in people suffering with different stages of emphysema, COPD, and other illnesses such as asthma.
- Signs of rejection in lung transplant patients could be discovered earlier.
- Radiotherapy for lung cancer could be more effective.
- Clinicians would know more about how lungs grow from infants to adults.

“ This will give us an initial baseline to create a more comprehensive data set to compare results. ”

- Researchers could determine the amount of damage done to the lungs of teens who are just beginning to smoke cigarettes and use that information for anti-smoking campaigns.

## Study results

The new science has produced amazingly accurate results. Using donor lungs that had been rejected for transplantation use, researchers were able to use <sup>3</sup>He lung morphometry to determine the depth, size, and number of the alveolar sleeves, ducts, and sacs. Then the specimens were frozen and examined under a microscope to see if



measurements were the same. “The measurements were almost identical,” Yablonskiy says. “It gave almost a perfect result. Our theory worked beyond what we expected.”

The findings, “Quantification of Lung Microstructure with Hyperpolarized Helium-3 Diffusion,” were published in August 2009 in the *Journal of Applied Physiology*.

Researchers from Washington University’s Radiology, Systems Engineering, Physics and Pulmonary departments also completed another published study that produced the same accurate measurements of alveoli in both healthy and damaged lungs of mice.

## The next step

The research team will use <sup>3</sup>He lung morphometry to study 100 patients—of different ages and including both healthy patients and those with lung problems. The study is funded by a four-year National Institute of Health grant. “This will give us an initial baseline to create a more comprehensive data set to compare results,” says Yablonskiy.

James Quirk, PhD, research instructor in radiology, and Jason Woods, PhD, assistant professor of radiology, have joined the lung imaging team and are applying Helium-3 lung morphometry to study mouse models with different lung diseases—a very important direction for understanding disease development and drug discovery.

“This new science just opens up an unimaginable number of experiments that were not possible before,” says Yablonskiy. **MIR**





**Circa  
1920s**

The actinographic laboratory at Washington University Medical Center was the forerunner of Mallinckrodt Institute, one of the five largest and most modern radiological centers worldwide.

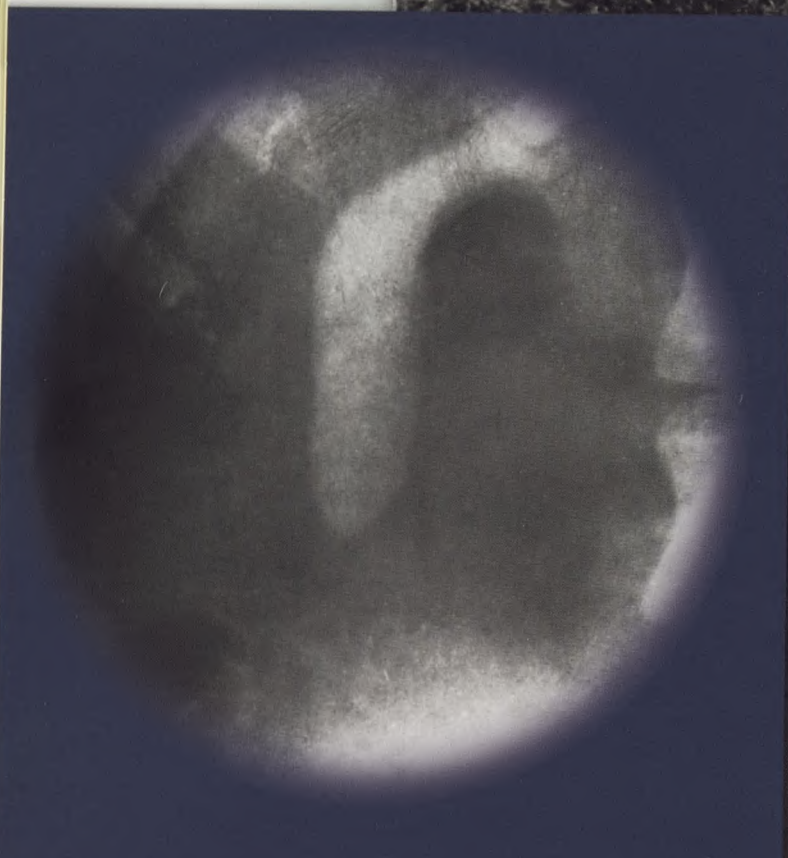
A **HISTORY** OF  
**MIR**

**The Mallinckrodt Institute lobby is a high-traffic area. So, what better place to provide visitors with snippets of MIR history and some visual stimulation?**

For the past eight years, posters featuring archival photos along with a brief description have been produced in-house as a joint effort of the MIR Publications Office and the Photography Lab. The posters are rotated monthly, with new ones being added as photos become available. The following pages include just a few of the poster series.

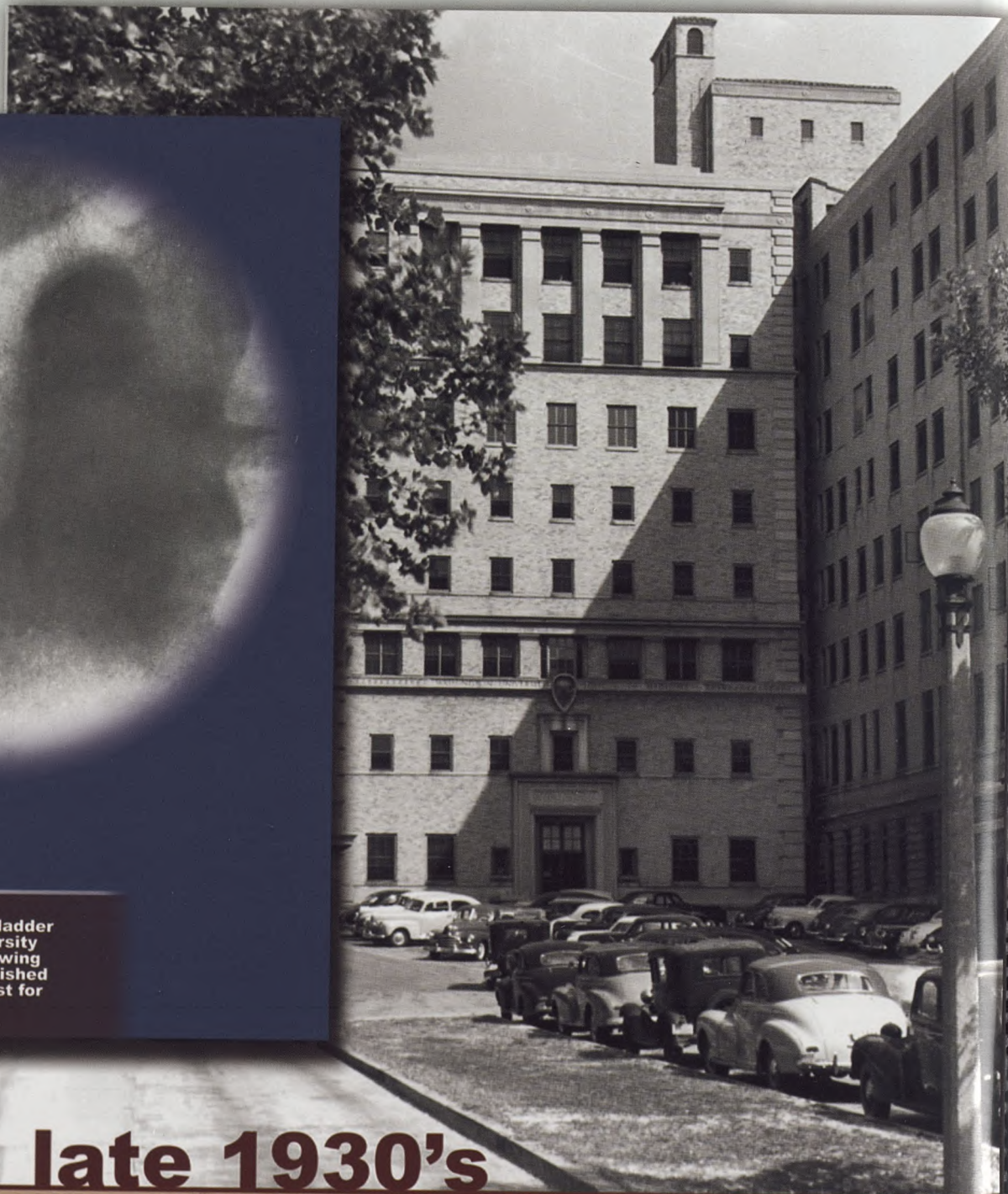


A HISTORY OF  
**MIR**



**1924**

First visualization of a human gallbladder (volunteer was a Washington University Medical Center student nurse) following injection of a contrast agent established the cystogram as the diagnostic test for gallbladder disease.



**late 1930's**

The front entrance to Mallinckrodt Institute of Radiology—when it was a free-standing building—faced Kingshighway Boulevard. On the left is a portion of St. Louis Children's Hospital (the current hospital at One Children's Place was built in 1984).

© Mallinckrodt Institute of Radiology, 2007



# WARD MALLINCKRODT INSTITUTE OF RADIOLOGY



**1964**

The A&P Bakery on Scott Avenue was purchased by Washington University School of Medicine (WUSM) in 1980. After extensive renovations, the building was reopened in 1984. The East Building, as it is now called, houses various WUSM groups, including many of Mallinckrodt Institute's imaging research labs.



**1963**

This Picker Cobalt-60, installed in the Institute's Radiation Oncology Center, was one of the nation's first modern, high-energy LINAC units used to treat cancer, especially cancer of the head and neck.

## Circa 1970s

Some of the earliest cardiac angiography studies were conducted at Mallinckrodt Institute. Prior to the introduction of spiral scanning and multislice technology, as provided by computed tomography, earlier technologies were too slow to capture high-resolution cardiac images.





# A HISTORY OF MIR



In **2003**

Swiss scientists arrived at Mallinckrodt Institute of Radiology (MIR) with a container full of 35,000-year-old human bone fragments found in a cave in Romania. Using high-resolution computed tomography with special software, MIR researchers fitted together matching pieces and generated a 3-D virtual model.

These reconstructed bones provided a clearer idea of what modern humans (no brow ridge and a defined chin) looked like and added important information for one of the greatest debates in anthropology today: What happened to the Neanderthals?

© Mallinckrodt Institute of Radiology, 2010

**2005**

An ultra-high field (11.75-tesla) magnetic resonance scanner was installed in the Institute's Scott Avenue Imaging Center for research use in the Biomedical Magnetic Resonance Laboratory.





*In this section, the names of employees who are full-time faculty or staff or who have an appointment in the Department of Radiology are highlighted in boldface type.*

## NEW FACULTY

### FIRST-YEAR FELLOWS

**Archana Abhyankar, MBBS**, abdominal imaging clinical fellow, received an undergraduate degree from Parle College, India, and a medical degree from Topiwala National Medical College, India. She completed a surgery internship at Montefiore Medical Center, New York, and a radiology residency at Bronx-Lebanon Hospital Center, New York.

**Per Amundson, MD**, diagnostic neuroradiology clinical fellow, received an undergraduate degree from the University of Utah and a medical degree from the Uniformed Services University of the Health Sciences, Maryland.

**Victor Anaya-Baez, MD**, abdominal imaging clinical fellow, received an undergraduate from Pontifical Catholic University of Puerto Rico and a medical degree from Universidad Central del Caribe School of Medicine, Puerto Rico. He completed an internship at Long Island College Hospital, New York, and a residency at the University of Louisville, Kentucky.

**Cameron Bahr, MD**, diagnostic neuroradiology clinical fellow, received an undergraduate degree from Brigham Young University, Utah, and a medical degree from the University of Utah School of Medicine. He completed an internship at the University of Utah; a residency at Hartford Hospital, Connecticut; and a musculoskeletal radiology fellowship at the University of Alabama, Birmingham.

**John Burda, MD**, interventional radiology clinical fellow, received an undergraduate degree from Vilanova University, Pennsylvania, and a medical degree from Drexel University College of Medicine, Pennsylvania. He completed an internship at Naval Medical Center San Diego-Balboa Park, California, and a radiology residency at Hahnemann University, Pennsylvania.

**Gerald Camren, MD**, interventional radiology clinical fellow, received undergraduate degrees from the University of Oklahoma and from Oral Roberts University, Oklahoma, and a medical degree from the University of Oklahoma College of Medicine. He completed an internship at Tucson Medical Center, Arizona, and a radiology residency at the university of Illinois Medical Center.

**Andrea Hong, MD**, breast imaging clinical fellow, received an undergraduate degree from Stanford University, California, and a medical degree from Duke University, North Carolina. She completed an internship at Advocate Christ Medical Center, Illinois, and a diagnostic radiology residency at the University of Pittsburgh Medical Center, Pennsylvania.

**Seth Klein, MD**, interventional radiology clinical fellow, received an undergraduate degree from the State University of New York and Hebrew University, and a medical degree from the University of Buffalo School of Medicine and Biomedical Sciences, New York. He completed a surgical internship and a residency at Stony Brook University Medical Center, New York.

**Meghna Krishnan, MBBS**, abdominal imaging clinical fellow, received an undergraduate degree from Mount Carmel College for Women, India, and a medical degree from Bangalore Medical College, India. She completed an internship at St. Francis Hospital, Illinois, and a diagnostic radiology residency at Yale University School of Medicine, Connecticut.

**Jon Machayya, MD**, interventional radiology clinical fellow, received an undergraduate degree from Concordia College, Minnesota, and a medical degree from the University of North Dakota School of Medicine and Health Sciences. He completed a surgical internship at Iowa Methodist Medical Center and a residency at St. Joseph's Hospital and Medical Center.

**Satheavy Moore, MD**, breast imaging clinical fellow, received an undergraduate degree from Louisiana State University at Shreveport and a medical degree from Louisiana State University Health Sciences Center. She completed an internship and a residency at Louisiana State University Health Sciences Center.

**Radha Popuri, MBBS**, interventional radiology clinical fellow, received an undergraduate degree from GCSS Junior College, India, and a medical degree from Osmania Medical College, NTR University of Health Sciences, India. He completed the specialist registrar in radiology training at Manchester Radiology Scheme, the University of Manchester, United Kingdom.



## NEW FACULTY

*Continued from page 27*

**Dharmesh Tailor, MD**, diagnostic neuroradiology clinical fellow, received an undergraduate degree from the University of Pennsylvania and a medical degree from the David Geffen School of Medicine, University of California, Los Angeles. He completed an internship at Pennsylvania Hospital, University of Pennsylvania Health System, and a residency at the Hospital of the University of Pennsylvania.

**Phuong Tran, MD**, musculoskeletal radiology clinical fellow, received an undergraduate degree from the University of Missouri-Columbia and a medical degree from the University of Missouri-Columbia School of Medicine. She completed an internship and a residency at the University of Missouri Health Care.

**Neel Varma, MD**, abdominal imaging clinical fellow, received an undergraduate degree and a medical degree from the University of Manitoba, Canada. He completed a family medicine residency at the University of Manitoba and a radiology residency at Saint Louis University, Missouri.

## FIRST-YEAR DIAGNOSTIC RADIOLOGY RESIDENTS

**Saurabh Agarwal, MD**, received an undergraduate degree from Cornell University, New York, and a medical degree from the University of Chicago, Pritzker School of Medicine. He completed an internship at the University of Pittsburgh Medical Center.

**Michael Dobson, MD**, received an undergraduate degree from Brigham Young University, Utah, and a medical degree from Washington University in St. Louis School of Medicine. He completed an internship at Loyola University Medical Center, Illinois.

**Guillermo Gonzalez-Araiza, MD**, received an undergraduate degree from Washington University in St. Louis and a medical degree from Washington University in St. Louis School of Medicine. He completed an internship at St. Vincent's Hospital, New York.

**Ronald Loch, MD**, received an undergraduate degree from Vanderbilt University, Tennessee, and a medical degree from Vanderbilt University School of Medicine.

**Rachel Loomans, MD**, received an undergraduate degree from the University of Wisconsin and a medical degree from the University of Wisconsin School of Medicine and Public Health.

**Matthew Niemeyer, MD**, received an undergraduate degree from the University of Michigan and a medical degree from the University of Michigan School of Medicine.

**Benjamin Northrup, MD**, received an undergraduate degree from Truman State University, Missouri, and a medical degree from Dartmouth Medical School, New Hampshire.

**Joseph Owen, MD**, received an undergraduate degree from Princeton University, New Jersey, and a medical degree from the University of Kentucky College of Medicine.

**Saurabh Prakash, MD**, received an undergraduate degree from Stanford University, California, and a medical degree from Stanford University School of Medicine.

**Alireza Radmanesh, MD**, received a medical degree from Tehran University of Medical Sciences, Iran. He completed a neuroradiology fellowship at Brigham and Women's Hospital, Massachusetts.

**Hillary Shaw, MD**, received an undergraduate degree from Wellesley College, Massachusetts, and a medical degree from the University of Maryland School of Medicine.

**Yeemie Sheref, MD**, received an undergraduate degree from the University of Pennsylvania and a medical degree from Washington University in St. Louis School of Medicine.

**Anup Shetty, MD**, received an undergraduate degree from Duke University, North Carolina, and a medical degree from the University of Texas Southwestern Medical School. He completed an internal medicine residency at Barnes-Jewish Hospital, Missouri.

**David Slat, MD**, received a medical degree from Temple University, Pennsylvania. He completed an internal medicine residency at Yale University, Connecticut.

**Taylor Stone, MD**, received an undergraduate degree from the University of North Carolina at Chapel Hill and a medical degree from the University of North Carolina School of Medicine.

**Anderanik Tomasian, MD**, received a medical degree from Shahid Beheshti University of Medical Sciences, Iran. He completed an internal medicine residency at Hospital of Saint Raphael, Connecticut.

**Noushin Yahyavi, MD**, received an undergraduate degree from the University of Tehran, Iran, and a medical degree from Tehran University of Medical Sciences. She completed a preliminary medicine internship at Cleveland Clinic, Ohio.



## FIRST-YEAR NUCLEAR MEDICINE RESIDENTS

**Garima Agrawal, MD**, completed premedical studies at S.S. Medical College, India, and received a medical degree from Gandhi Medical College, India. She completed an internship and a radiology residency (chief resident) at Gandhi Medical College. She was a research associate in functional renal MR imaging in the Department of Radiology at the University of Wisconsin School of Medicine and Public Health.

**Dhanashree Rajderkar, MD**, received an undergraduate degree in medicine and surgery at Government Medical College, India. She completed a radiology residency at the Indra Gandhi Medical College, India. She was a research fellow in neuroradiology at the University of Southern California.

**Kenneth Winkler, MD**, received an undergraduate degree in biology from Loyola Marymount University, California, and a medical degree from Creighton University School of Medicine, Nebraska. He completed a diagnostic radiology residency at Southern Illinois University.

## GRANTS

**Tammie Benzinger, MD, PhD**, assistant professor of radiology, as principal investigator, received a two-year grant of \$82,500 from the Barnes-Jewish Hospital, Clinical and Translational Sciences Research Program, for "QBOLD MR measurements of oxygen extraction in patients with brain tumors."

**Delphine Chen, MD**, assistant professor of radiology, as principal investigator, received a one-year grant of \$82,500 from the Barnes-Jewish Hospital, Clinical and Translational Sciences Research Program, for "PET imaging of endotoxin-induced iNOS activation in healthy volunteers." As principal investigator, she received the Doris Duke Foundation Clinical Scientist Award—a three-year grant of \$486,000—for research on "Noninvasive quantification of the pulmonary anti-inflammatory effect of rosiglitazone."

**Robert Mach, PhD**, professor of radiology, of cell biology and physiology, and of biochemistry and molecular biophysics, as principal investigator, received a five-year grant of \$1.2 million from the National Institutes of Health/National Institute on Drug Abuse, for "PET radiotracers for imaging the dopamine D<sub>3</sub> receptor."

**Barbara Monsees, MD**, professor of women's health and of radiology, as principal investigator, received a 1-year grant of \$29,128 from the Barnes-Jewish Hospital, Clinical and Translational Sciences Research Program, for breast imaging and cancer research.

**Yuan-Chuan Tai, PhD**, associate professor of radiology, as principal investigator, received a \$1 million grant from the National Science Foundation for "MRI: development of a high-resolution positron imaging system dedicated to plant research." Coinvestigators for the three-year grant are Jacob Schaefer, PhD, professor of chemistry; Lee Sobotka, PhD, professor of chemistry; **Suzanne Lapi, PhD**, assistant professor of radiology; and Joseph O'Sullivan, PhD, professor of electrical engineering. As principal investigator, Tai also received a \$1.2 million grant from the Department of Energy for "Development of simultaneous beta-and-coincidence-gamma imager for plant imaging research." Coinvestigators for the three-year grant are Schaefer and Sobotka.

## Melson Lecture

On September 22, Byung I. Choi, MD, PhD, internationally acclaimed for his clinical, research, and teaching activities focusing on hepatocellular carcinoma, presented the Eighteenth Annual G. Leland Melson Visiting Professorship and Lecture. Choi, professor of radiology at Seoul National University and Seoul National University Hospital, spoke on "Recent advances in imaging of hepatocellular carcinoma."



Choi (left) with Jay Heiken, MD, professor of radiology.



## APPOINTMENTS/ ELECTIONS

**Colin Derdeyn, MD**, professor of radiology, of neurology, and of neurologic surgery, was appointed to a two-year term on the American Heart Association (AHA) Oversight Committee and to a two-year term on the AHA Council Operations Committee.

**Linda Larson-Prior, PhD**, research associate professor of radiology, was appointed as a member of the Organizing Committee for the Neuroimaging Technologies for Optimizing Performance Workshop, sponsored by Virginia Polytechnic Institute and State University's Arlington Innovation Center for Health Research and in partnership with the United States Army Telemedicine and Advanced Technology Center, Alexandria, Virginia, September 23 and 24.

**Bruce Whiting, PhD**, research assistant professor of radiology, was elected Senior Member of the Optical Society of America.

## LECTURES

**Mikhail Berezin, PhD**, assistant professor of radiology, presented "Nanotransducers and nanothermometers for medical applications" at Washington University Frontiers, St. Louis, Missouri, September 25. He spoke on "Multiphoton FLIM with near-infrared dyes" at the 4th Boston TCSPC Workshop on Advanced TCSPC Techniques, Boston, Massachusetts, October 11 and 12.

**Colin Derdeyn, MD**, professor of radiology, of neurology, and of neurological surgery, presented "SAMM-PRIS Trial update" at the American Society of Neuro-radiology Annual Meeting, Boston, Massachusetts, May 20; at the Society of

NeuroInterventional Surgery Practicum, Boston, May 22; and at the Society of NeuroInterventional Surgery Annual Meeting, San Diego, California, July 25.

**Steven Don, MD**, associate professor of radiology, spoke on "Pediatric Digital Radiography Summit synopsis" at Radiology Vitals, sponsored by Carestream, Inc., Rochester, New York, September 16.

**Louis Gilula, MD**, professor of radiology, of orthopedics, and of reconstructive surgery, presented "Ligamentous instabilities of the wrist" at the International Skeletal Society Annual Meeting, Athens, Greece, October 1. He spoke on "Facet blocks, median branch blocks, synovial cyst aspiration/"

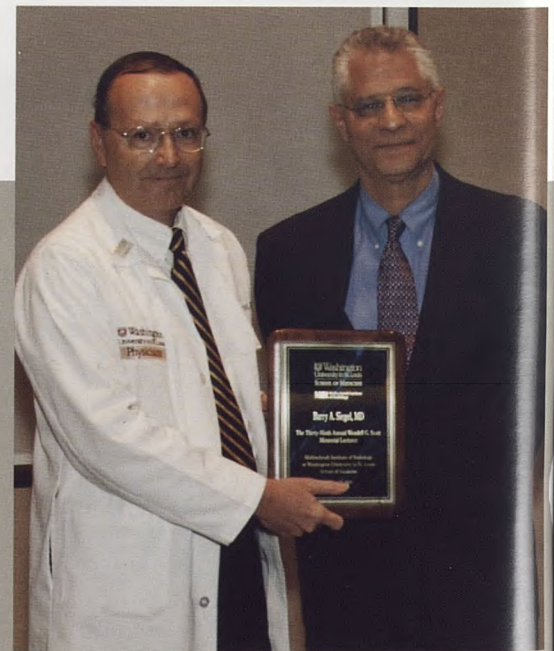
treatment, and sacroiliac joints, at the Hands-on Image-guided Spine Intervention Course, sponsored by the American Society of Spine Radiology, Baltimore, Maryland, October 22-24.

**Pilar Herrero, ME, MS**, research associate professor of radiology, as lead author, presented "PET imaging of cardiac iNOS levels in humans using 18F-NOS: a feasibility study" at the Society for Heart and Vascular Metabolism 8th Annual Meeting, Kananaskis, Alberta, Canada, August 22-25.

**Geetika Khanna, MD**, associate professor of radiology, spoke on "Diffusion weighted imaging for evaluation of Crohn's disease" at Children's Hospital of Philadelphia, Pennsylvania, May 12.

## Scott Lecture

Barry Siegel, MD, professor of radiology and of medicine and vice-chair for nuclear medicine at Mallinckrodt Institute, presented the Thirty-ninth Annual Wendell G. Scott Memorial Lecture on October 20. Siegel, who has devoted much of the last five years to the development and operation of the National Oncologic PET Registry, spoke on "Impact of PET and PET/CT on management of cancer."



Gilbert Jost, MD, (left) presented a commemorative plaque to Siegel.



**John Kotyk, PhD**, research associate professor of radiology, presented "In situ imaging of root structure using dual energy computed tomography" at Monsanto Company, St. Louis, Missouri, August 31. He spoke on "Support and services of the Human Imaging Unit of the ICTS" at the American College of Radiology Imaging Network meeting, Washington, DC, September 29.

**Linda Larson-Prior, PhD**, research associate professor of radiology, spoke on "Modulation of functional neural networks in the transition from wake to sleep" at the 26<sup>th</sup> International Summer School of Brain Research, Amsterdam, The Netherlands, June 29-July 2, and at Samsung Medical Center, September, Seoul, Korea. She presented "The promise of neuroimaging in human sleep research" at the Neuroscience Research Institute, Gachon University of Medicine and Science, Incheon, Korea, September. She spoke on "The imaging neural state changes of sleep and pathologies of attention" at the Neuroimaging Technologies for Optimizing Performance Workshop, sponsored by Virginia Polytechnic Institute and State University's Arlington Innovation Center for Health Research and in partnership with the United States Army Telemedicine and Advanced Technology Center, Alexandria, Virginia, September 23 and 24.

**Robert McKinstry, MD, PhD**, professor of radiology and of pediatrics, presented "QA and site certification," "Trials & Tribulations: Multi-center Trial Headaches & Their Cures," and "Neonatal imaging: opportunities & challenges," Emerging Techniques in Advanced Pediatric Neuroimaging, at the International Society of Magnetic Resonance in Medicine Annual Meeting, Stockholm, Sweden, May 4. He presented, as the Twenty-eighth Annual Harvey White Lecturer, "Imaging of brain injury in newborns," Pediatrics Grand Rounds, Children's memorial Hospital, Chicago, Illinois, November 5.

**Robert Mach, PhD**, professor of radiology, of cell biology and physiology, and of biochemistry and molecular biophysics, spoke on "New radiopharmaceuticals for PET: current status and challenges" at the 1<sup>st</sup> International Symposium on Converging Research for Frontier Medical Instruments, Seoul, Korea, May 27. He presented "The use of radiometals in nuclear medicine imaging procedures" at the 2010 Northeast Regional Meeting of the American Chemical Society, Potsdam, New York, June 3.

**Barry Siegel, MD**, professor of radiology and of medicine, as the 35<sup>th</sup> Eugene P. Pendergrass Lecturer, spoke on "National Oncologic PET Registry (NOPR): background and operational overview" at the Annual Pendergrass Day Symposium, University of Pennsylvania, Philadelphia. He presented "PET and PET/CT in pediatric oncology" at the 2010 Chinese National Conference on Recent Advances in Pediatric Diagnostic Imaging, Beijing, People's Republic of China, September 1. He spoke on "PET and PET/CT," "Newer approaches to treatment response prediction and monitoring," and "PET reimbursement update" at the National Diagnostic Imaging Symposium, Orlando, Florida, December 9.

**Marilyn Siegel, MD**, professor of radiology and of pediatrics, spoke on "Abdominal neoplasm: Wilms tumors and neuroblastoma" at the American Roentgen Ray Society Refresher Course, Evidence-Based Imaging Approach, San Diego, California, May 3 and 4. As visiting professor, she spoke on "MR in hepatic parenchymal disease: anatomic to functional imaging"; "Liver masses—rad/path correlation"; "CTA of mediastinal vascular anomalies"; and "CTA/MRA of congenital heart disease" at Radiology Grand Rounds, Children's Hospital of Philadelphia, Pennsylvania, June 10 and 11.

Siegel presented "Pediatric mediastinal masses," "Mediastinal vascular anomalies," and "Congenital brain anomalies: multimodality imaging" at the 2010 Chinese National Conference on Recent Advances in Pediatric Diagnostic Imaging, Beijing, People's Republic of China, September 1 and 2. As invited speaker, she presented "Radiation protection in pediatric imaging" at the Multimodality Imaging Symposium, Vancouver, Canada, September 25. As invited lecturer, she spoke on "CT and radiation dose issues: what you need to know"; "CT imaging of the pediatric patient: cardiothoracic applications"; "CT imaging of the pediatric patient: abdominal applications"; and "High resolution chest CT: principles and applications" at Essentials in Multidetector CT and CTA for the Technologists, Las Vegas, Nevada, October 7-10. Siegel spoke on "Radiation risks in CT imaging," "Mediastinal vascular variants and anomalies," and "CT of common abdominal masses in children" at the 15<sup>th</sup> Annual Computed Tomography 2010: National Symposium, Las Vegas, Nevada, October 21-24. She presented "CTA/MRA of hepatic masses in children," "Congenital mediastinal vascular anomalies," and "Ultrasound as a practical tool for evaluation of the acute pediatric abdomen" at the National Diagnostic Imaging Symposium, Orlando, Florida, December 9.



## SYMPOSIA

*In this section of FYI, only those faculty and staff who have Department of Radiology appointments are listed.*

### SOCIETY OF NUCLEAR MEDICINE

*57th Annual Meeting  
Salt Lake City, Utah  
June 5-9, 2010*

**Farrokh Dehdashti, MD**, comoderator, Oncology-Basic Science: Tumor Hypoxia.

**Bennett Greenspan, MD**, moderator, A Primer on Molecular Biology for Imagers—Part I and Part II; moderator, Tom Miller Memorial Lecture; organizer and moderator, Hal Anger Memorial Lecture.

**Suzanne Lapi, PhD**, comoderator, New Radiopharmaceuticals—Novel Probe Development I: Peptides; organizer and comoderator, Emerging Technologies: New Molecular Imaging Agents; organizer and comoderator, Emerging Technologies: Instrumentation.

**Henry Royal, MD**, comoderator, Radiation Risk/Toxicity Versus Benefits of Diagnostic and Therapeutic Nuclear Medicine Procedures: How to Best Put These in Perspective for Both Clinicians and Patients?

### PRESENTATIONS

**Paul Carey; Yongjian Liu, PhD; Maiko Kume; Suzanne Lapi, PhD; Michael Welch, PhD**, “The production of high specific activity Cu-64 as measured by ion chromatography.”

**Farrokh Dehdashti, MD**, “Future directions: PET to guide endocrine therapy of breast cancer,” “The role of PET/CT in cervical cancer.”

**Carmen Dence, MS; Michael Welch, PhD**, “Automated synthesis of 16,-[<sup>18</sup>F]fluoro-5-dihydrotestosterone using a plastic cassette-type FDG synthesizer.”

**Jinda Fan, PhD; Gregory Gaehle; Robert Mach, PhD; Zhude Tu, PhD**, “Automated radio-synthesis of clinical-grade [<sup>11</sup>C]morphine with a methylation module.

**Robert Gropler, MD**, “Unmet needs in cardiovascular imaging: contribution of molecular imaging”; “A tutorial on myocardial metabolism”; “Imaging the diabetic myocardial metabolic phenotype: from bench to bedside.”

**Oluwatayo Ikotun, PhD; Suzanne Lapi, PhD**, “Investigating the potential of Cu-64-annexin V as an imaging agent for cell death.”

**Maiko Kume; Paul Carey; Suzanne Lapi, PhD; Michael Welch, PhD**, “The development of automated Yttrium-86 processing at Washington University.”

**Robert Mach, PhD**, “The development of a radiopharmaceutical for molecular imaging,” “Basic molecular imaging to clinical PET: proliferation markers in cancer.”

**Robert Mach, PhD; Zhude Tu, PhD; Jinbin Xu, PhD; Suwanna Vangveravong, PhD; Shihong Li, MD; Jinda Fan, PhD; Lynne Jones; Joel Perlmutter, MD**, “Differential distribution of dopamine D<sub>2</sub> and D<sub>3</sub> receptors in the Rhesus brain measured with PET.”

**Henry Royal, MD**, “What is the relationship between dose and risk? How is this determined?”; “Is there a death toll from diagnostic imaging???”; “MOC: meaningless bureaucracy or essential for health care?”

**Tae Yong Song; Heyu Wu, PhD; Yuan-Chuan Tai, PhD**, “Development of a SiPM block detector for a sub-millimeter resolution PET insert.”

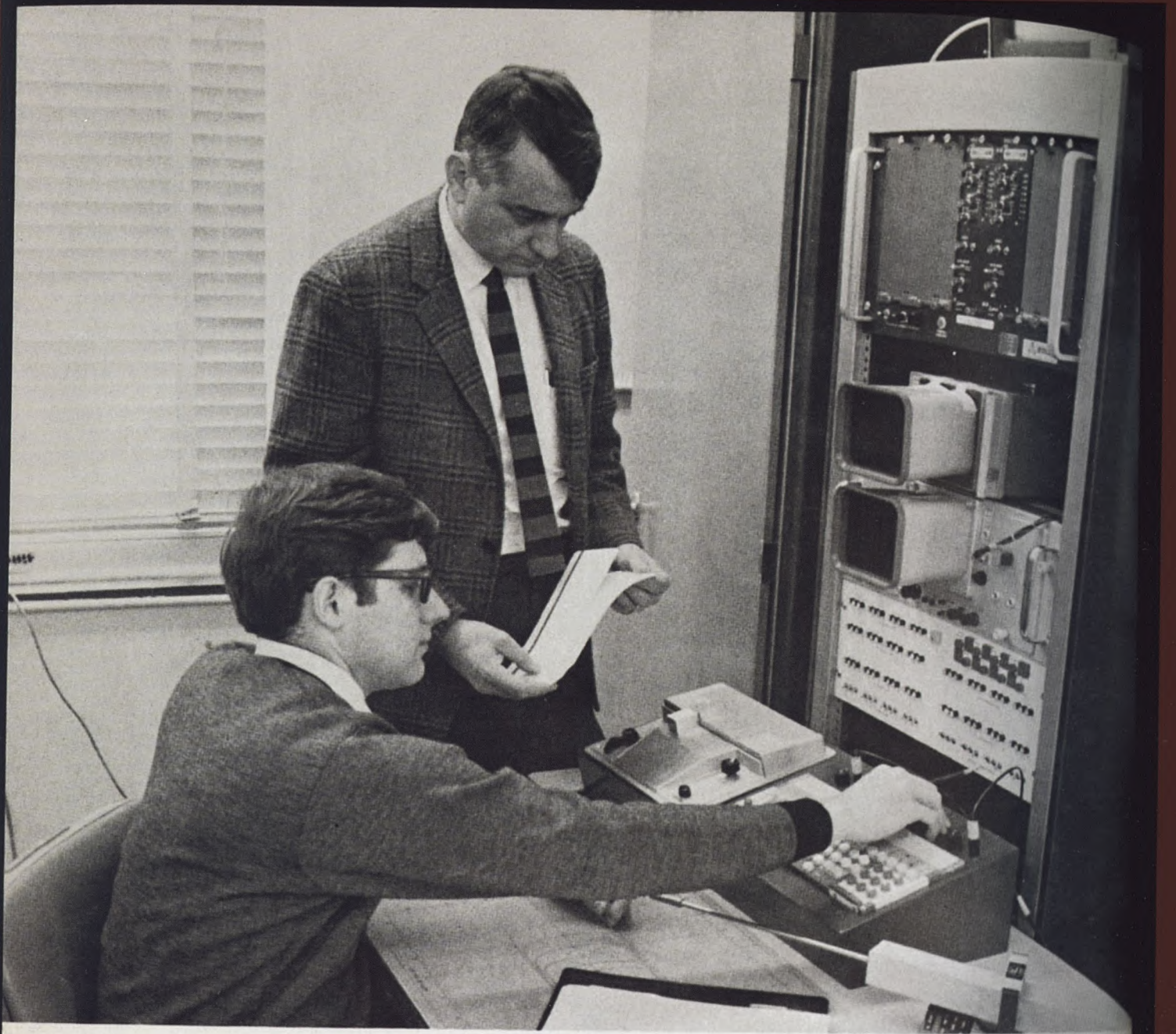
**Zhude Tu, PhD; Shihong Li, MD; Jinbin Xu, PhD; Lynne Jones; Robert Mach, PhD**, “Synthesis, radiosynthesis and in vivo evaluation of a carbon-11 labeled <sup>2</sup>PET radiotracer for imaging solid tumors.”

**Michael Welch, PhD**, “Radiopharmaceutical sciences.”

**Dexing Zeng, PhD; David Reichert, PhD**, “Microfluidic radiolabeling of biomolecules with Cu-64.”

**Editor's Note:** Due to unforeseen circumstances, this issue of *Focal Spot* magazine was delayed. I apologize for any inconvenience this delay may have caused. Future issues will be distributed according to the regular schedule.





*Dr. Jerome Cox, Jr., Director, discusses a project with a student working at the LINC.*

## BIOMEDICAL COMPUTER LABRATORY

# LINC

The versatile and powerful Laboratory Instrument Computer (LINC) established Washington University as a leader in solving biomedical problems with computers. This photo was featured in the 1968 Washington University School of Medicine *Bulletin*.



# FOCAL SPOT

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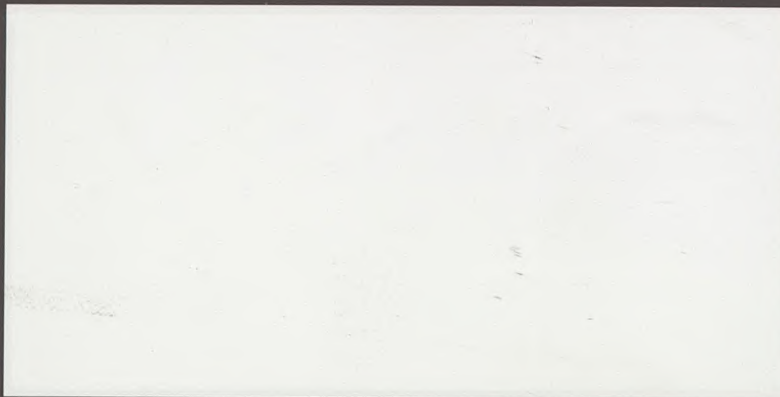
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