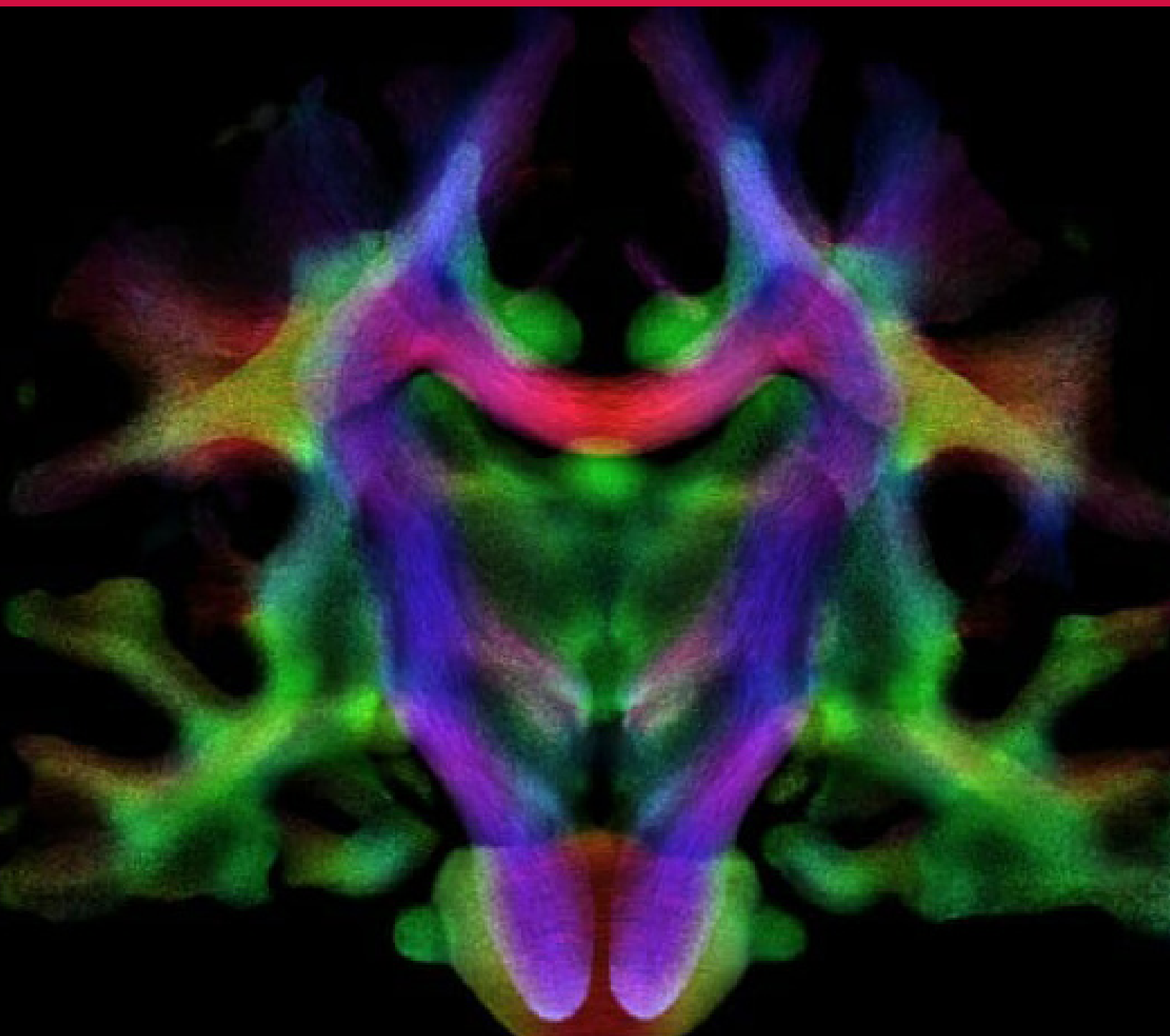
Summer 2022

Medical Physics
UNIVERSITY OF WISCONSIN
SCHOOL OF MEDICINE AND PUBLIC HEALTH

The Medical Physicist



Inside This Issue

UW-Madison Medical Physics

@wiscmedphys

Department Chair: Brian Pogue, PhD
Department Administrator: Kristina Weaver, MBA

Newsletter Design: Alyssa Mohr

On the Cover

Prospective students visited the UW campus during the Department of Medical Physics open house event in spring 2022.

Winner of the 2021 UW Cool Science Image Contest.

White matter, the connective nerve tissue of the brain, has been colored according to the predominant orientation of fibers-red, right-left; green, front-back; blue, up-down - in different regions of the human brain to reveal pathways traversing the regions. Understanding white matter organization may offer insights into normal brain development as well as into the study of neurological disorders.

Picture curtesy of Jose Guerrero, postdoctoral fellow, Medical Physics; Andrew Alexander, professor, Medical Physics; Peter Ferrazzano, professor, Pediatrics. Taken on an MRI scanner.

Greetings from the Chair

Professor Brian Pogue

To our Alumni & Former & Current Faculty, Students, Residents, & Staff:

On behalf of the entire department, I am happy to lead off this edition of the Department of Medical Physics annual newsletter. This past year was nothing close to ordinary and I want to applaud everyone, especially our students, for your tenacity, perseverance, and flexibility over the last two years as we have navigated the seemingly unending uncertainties from the coronavirus pandemic and changes in staff and leadership. Despite our changes, we continue to make great strides in our research, service and educational efforts.

It has been a great privilege for me to get to know the students, researchers, and staff of the department over these last six months, and I am ecstatic to continue in this path of community building within the School of Public Health and the University of Wisconsin. Together with the Vice-Chairs, Staff and Faculty, we are planning for the future of this seminal department.

As leaders in medical physics, it is our responsibility to take action against racism and intolerance and to cultivate an inclusive and welcoming environment for all those we employ, teach and serve. This year we are once again renewing our commitment to diversity, equity and inclusion, and look forward to continued learning opportunities that will be facilitated through planned roadmaps for our faculty and students. This needs to be planned and open, and we hope to have a set of conscious efforts in place for the new academic year.

As always, we are eager to hear from our alumni and former faculty and staff. Please send any informational updates, such as changes of address, to Kristina Weaver, MBA (kmweaver@wisc.edu). If your travels bring you to or near Madison, please let us know, as we would be very pleased to see you and schedule a department visit. Please also follow us on social media.

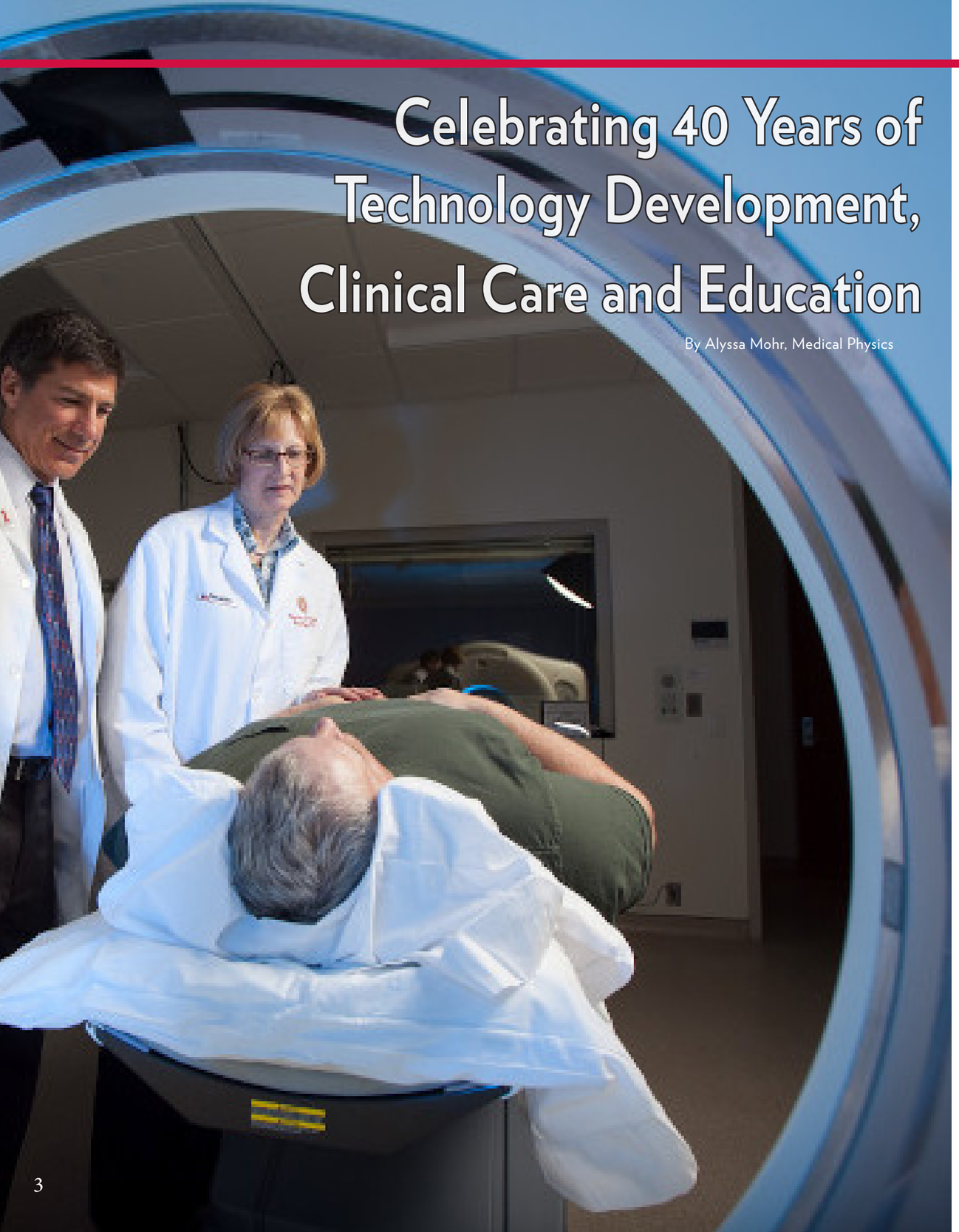
With regard to philanthropy, I sincerely thank all alumni and present and former faculty and staff who contributed donations throughout the past year. I encourage each of you to review Page 18 of this newsletter to identify opportunities where you can contribute to the continued successes and improvement of the department. Philanthropic support of each of the department's mission areas is critical to success, and this means of financial support continues to become increasingly important. Please consider contributing.

As this issue of The Medical Physicist goes live, our campus is preparing for a return of students for the upcoming fall semester. In addition to our returning students, this fall we will be welcoming the largest incoming class of medical physics graduate students, to date, – something we are tremendously excited about.

It is an honor and privilege to serve as Department Chair of such a phenomenally accomplished and singular department, and I look forward to the future that we will create here together.

On, Wisconsin!

Brian Pogue, PhD



Celebrating 40 Years of Technology Development, Clinical Care and Education

By Alyssa Mohr, Medical Physics

In the not-too-distant past, clinical medical imaging could rely only on simple X-ray images on film. Back then, unfortunately, patients often had to undergo "exploratory surgery" to investigate illnesses beyond what physicians could learn from common clinical evaluations and X-rays.

And while radiation therapy has been a tool to treat cancer for nearly 100 years, the initial methods were in their infancy. Advances beyond the early days of medical imaging and gamma-ray treatments have relied heavily on the involvement of physicists in medicine.

Advancements in understanding how to safely use X-ray and gamma-ray radiation — and how to protect patients from excess exposure — have led to X-ray computed tomography (CT) imaging and positron emission tomography (PET) imaging, as well as advancements in radiation therapy and treatment planning. Physicists also have been integral to the development and advancement of magnetic resonance imaging (MRI) and the use of high-frequency sound waves (ultrasound) in medical imaging.

While medical imaging and radiation therapy for cancer treatment have become mainstream in nearly every U.S. health care facility, we pause to reflect upon researchers in the Department of Medical Physics at the University of Wisconsin School of Medicine and Public Health who contributed to and/or invented many aspects of today's technology, including solutions for accurate diagnosis and optimized treatment of human disease. These teams of investigators are among the masterminds who made these celebrated technologies a reality throughout the department's 40-year history.

Medical physics is the application of physics concepts and methods to diagnose and treat human diseases. The field combines and applies physics and math to medicine, and it is the foundation of radiology, radiation oncology and nuclear medicine. Faculty and staff in the Department of Medical Physics play an increasingly vital role in the discovery of diagnostic techniques and promising treatment modalities.

A distinguishing feature of the Department of Medical Physics is its setting within a top-tier research institution. With long-standing, close collaborations with departments across the School of Medicine and Public Health, UW College of Engineering and other UW-Madison units, as well as with industry partners, the Department of Medical Physics is at the forefront of building relationships to advance research, patient care and education.

As the first stand-alone medical physics program in the United States, established in 1981, the Department of Medical Physics also trains the next generation of medical physicists through its graduate, residency and fellowship programs.

Further, notable faculty members have successfully patented and licensed numerous inventions, including:

- Digital subtraction angiography, a type of X-ray fluoroscopy technique used in interventional radiology to visualize blood vessels in a bony or dense soft tissue environment;
- Pinnacle radiation treatment planning software, now used worldwide;
- Tomotherapy, a system that delivers precise doses of radiation to tumors while allowing physicians to monitor treatment with a built-in CT scanner;
- Ultrasound tissue-mimicking materials that are used in machine calibration, medical imaging research and surgical simulation, and ultrasound of phantoms that mimic the properties of human tissue.

The department's faculty members are among the top royalty recipients at the Wisconsin Alumni Research Foundation — UW-Madison's patenting and licensing organization — which helps advance transformative discoveries to market.

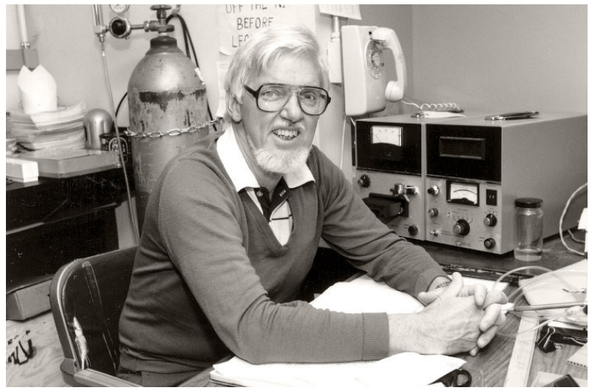
Yet, medical physicists' important work generally goes unseen by patients. Akin to the wizard from the Wizard of Oz, they use their skills "behind the curtain" to make sure patient care, including personalized medicine, is effective, accurate and efficient.

Virtually all U.S. hospitals now have medical physicists on staff to ensure quality in imaging techniques and to help administer radiation therapy. Calling upon their understanding of molecular biological processes, the School of Medicine and Public Health's medical physics researchers are key leaders in studying how radiation affects the body; developing new radiation safety procedures; and researching options for the detection, evaluation and treatment of human diseases such as cancer, mental illness, organ failure and neurodegenerative diseases.

Together with their clinical colleagues, these medical physicists advance state-of-the-art patient care by developing, validating and translating to the clinical environment novel imaging systems, minimally invasive techniques, personalized treatments and early treatment assessment. Our board-certified clinical faculty members provide expert medical physics services to clinical facilities in Madison, the state of Wisconsin and beyond.

The Department of Medical Physics' history started in 1958, when John R. Cameron, PhD '52 — who founded and became the first chair of that department — took on a unique joint appointment between the Department of Physics and Department of Radiology. Cameron soon began attracting physics students to study and perform research in the new area of applied physics. This process accelerated after Cam eron obtained a research grant from the Atomic Energy Commission to study thermoluminescent dosimeters and funding from the National Aeronautics and Space Administration for his work measuring bone minerals in vivo.

Cameron always credited the growth and success of the young Department of Medical Physics to John Juhl, MD (PG '49), former chair of the Department of Radiology, and colleagues in the Department of Physics for their support in allowing him the capacity to engage in this new era of research opportunities. Even today, many of the 30 faculty members in the Department of Medical Physics hold affiliate appointments in one or more clinical departments. These include the Departments of Radiology, Human Oncology, Psychiatry, Pediatrics and Medicine. Several faculty members also have joint appointments in nuclear engineering, electrical engineering and/or biomedical engineering in the UW College of Engineering.



Continuing to grow the Department of Medical Physics, Cameron recruited talented physicists — many from the UW Department of Physics — including Frank Herbert (Herb) Attix, who, with Paul M. DeLuca Jr., PhD, advanced knowledge about the interaction of ionizing radiation with matter, specifically with implications for instrumentation and radiological physics measurements; Charles (Chuck) Kelsey, PhD, who pioneered ultrasound techniques in medicine; Charles (Chuck) Mistretta, PhD, who established quantitative imaging techniques and led the team that invented digital subtraction angiography; Paul Richard (Dick) Moran, PhD, who developed methods to measure blood flow and motion in the human body using MRI; and Robert Jerome (Jerry) Nickles, PhD '68, who did pioneering work in the area of PET imaging and the use of particle accelerators for radionuclide production for nuclear medicine. It is through these and similar ongoing investigations that research has evolved to answer the call of achieving better patient care. Such collaborations also led to technologies and processes that push forward the benchmark of what medicine can do.

Many start-up companies have roots in the Department of Medical Physics. Examples are:

- Lunar BMD
- Tomotherapy
- Pinnacle Treatment Planning Software
- Standard Imaging
- Radiation Measurements, Incorporated
- Marvel MedTech
- TherVoyant
- AIQ Solutions
- Medical Physics Publishing

With these successful spin-off companies, a plethora of successful patented contributions to medicine and more than 900 graduate program alumni, the Department of Medical Physics has proven to be a significant contributor to the discovery of new technology, as well as the training of radiologists and the next generation of medical physicists.

Throughout its years of growth and change, the department continues to rank among the top medical physics graduate programs in the nation.

UW-Madison Medical Physics Degrees Awarded

Congratulations to the Medical Physics graduates of 2022! Spring graduates were invited to attend an in-person ceremony at the Kohl Center on Friday, May 13, 2022. The ceremony included speeches from Honorary Degree Recipients Krishna Ella, a groundbreaking vaccine scientis and entrepreneur; Keith Nosbusch, a visionary who reinvented industrial automation for the 21st centure; and Ernest Grant, president of the American Nurses Association and a burn care expert known for his work treating victims of 9/11.

Doctoral Degrees

Peter Ferjancic
Advisor: Dr. Jeraj

William Ferris
Advisor: Dr. Culberson

Emily King
Advisor: Dr. DeWerd

Ian Marsh
Advisor: Dr. Bednarz

Chenwei Tang
Advisor: Dr. Johnson

Autumn Walter
Advisor: Dr. DeWerd

Doctoral Degrees
Anticipated August 2022 Graduation

David Adam
Advisor: Dr. Bednarz

Daniel Huff
Advisor: Dr. Jeraj

Sydney Jupitz
Advisor: Dr. Bednarz

Christopher Kutyreff
Advisor: Dr. Engle

Lawrence Lechuga
Advisor: Dr. Fain

Jason Moody
Advisor: Dr. Alexander

Ruiyang Zhao
Advisor: Dr. Hernando

Master's Degrees

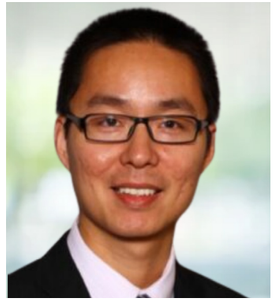
Nathan Cudworth
Advisor: Dr. Eliceiri

Riley Tegtmeier
Advisor: Dr. Culberson

Faculty & Staff Promotions

Jonathan Engle, PhD

Diego Hernando, PhD



Ke Li, PhD

Todd Barnhart, PhD

Congratulations to Drs. Engle, Hernando and Li who were promoted to Associate Professor with Tenure, effective July 1, 2022. Dr. Todd Barnhart, Senior Scientist in the Cyclotron Labratory, received a promotion to Distinguished Senior Scientist status in 2022. The Distinguished status is reserved for a select number of academic staff members who demonstrate superlative accomplishments evidenced by their peers and reputation in their field.

The past academic year marked the return of in-person conferences and conventions for students and faculty, and provided many well-deserved recognitions for outstanding faculty, staff and students. We are eager for the continuation of in-person conferences again and the opportunities to network and learn from colleagues across the globe! To stay up to date on the newest departmental awards, follow us on social media!

(Left) Scientist Ran Zhang, PhD wins a Roadie Award for the top abstract in the Road to RSNA preview of the digital x-ray sessions at RSNA 2021.

(Right) Graduate student William Ferris wins 2nd prize at the AAPM Early Career Investigator Symposium at the 2022 AAPM Spring Clinical Meeting.

(Bottom, Left) Graduate student Tarun Naren presents his research at ISMRM 2022.

(Bottom, Right) Graduate students Hayley Whitson, Lucky Volety and Sheena Chu at the Graduate Women in Science National Conference.

STUDENT OUTREACH & INVOLVEMENT

Graduate student Lucky Volety at the 2022 UW Physics Fair.

Graduate student Laura Castaneda-Martinez demonstrates ultrasound imaging to children at the 2022 UW Physics Fair.

Graduate students Nicholas Summerfield, Lisette LeMerise, Alex Christensen and Sydney Jupitz at the 2022 UW Science Expeditions event.

The Medical Physics Graduate Student Outreach committee aims to increase the visibility of medical physics by teaching community members about the role of physics in medicine, as well as educational and career opportunities in physics-based careers. The committee focuses on educating the next generation of curious thinkers, especially under-represented groups in medical physics, by engaging them in coversation and hands-on medical physics activities.

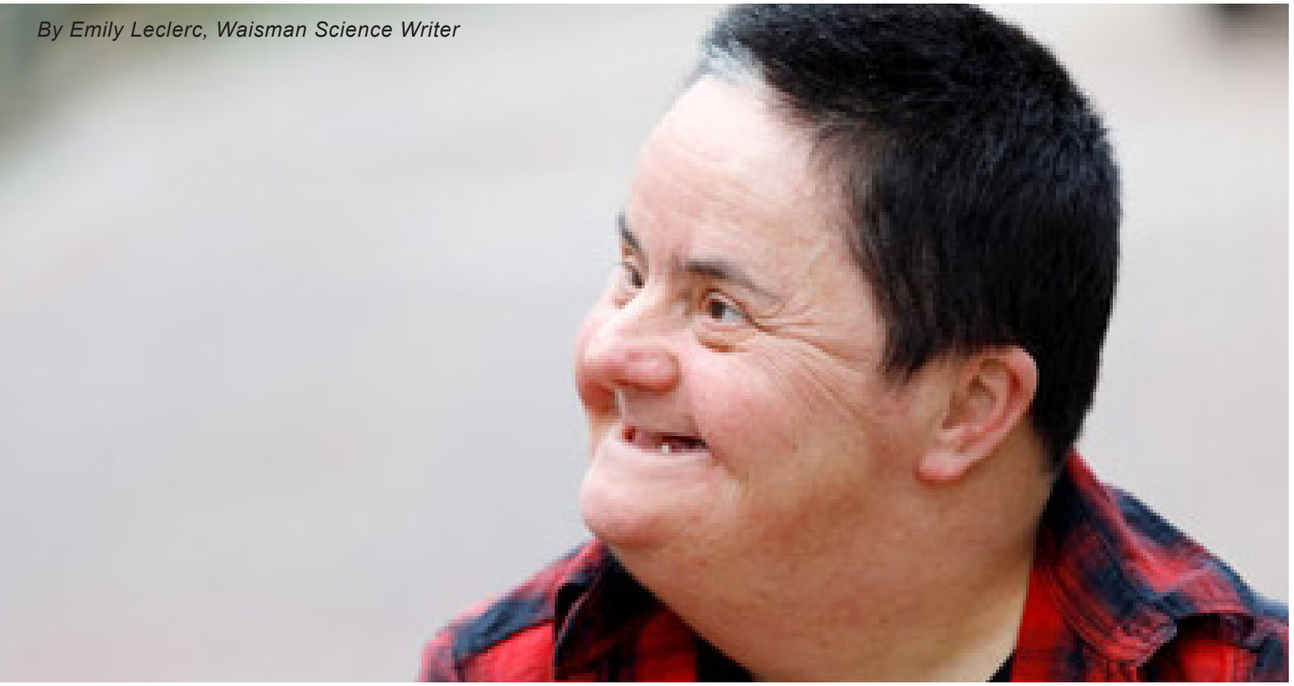
Throughout the 2022 academic year, the medical physics graduate students involved in outreach participated in several events on the UW campus and surrounding Madison community. Events included the UW Physics Fair, UW Science Expeditions, and elementary school outreach at Anana Elementary science and literacy night.

At the various events, community members could explore ultrasound imaging by investigating gelatin phantoms, identify body parts from X-ray film and printouts., and learn about the history and safety of radiation use.

Graduate students are encouraged to participate in future outreach events. Please see the department website for additional information about upcoming events and opportunities to get involved.

Studying the Connection Between Alzheimer's And Down Syndrome

By Emily Leclerc, Waisman Science Writer



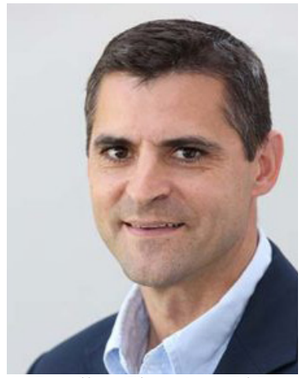
While people with Down syndrome often live long and fruitful lives, the condition does come with increased risks for certain diseases, Alzheimer's disease being one of them.

Due to the extra twenty first chromosome that causes the condition, people with Down syndrome are at greatly increased risk for developing Alzheimer's during their lifetime. It is estimated that by age 65, 90% of people with Down syndrome will have developed Alzheimer's.

To better understand Alzheimer's disease in individuals with Down syndrome, Waisman Center investigator Brad Christian, PhD, a professor of medical physics and psychiatry, is one of four lead investigators in a national, longitudinal, National Institutes of Health-funded study that is investigating the role of biomarkers in the development of Alzheimer's disease.

A total of nine sites are participating in the study with Ben Handen, PhD, of the University of Pittsburg and Elizabeth Head, PhD, and Mark Mapstone, PhD, of the University of California, Irvine accompanying Christian as lead investigators. The study, Alzheimer's Biomarkers Consortium – Down Syndrome, or ABC-DS, uses positron emission tomography (PET) imaging, magnetic resonance imaging (MRI) and biofluid measures to look for early biomarkers, or changes in the brain, that may herald the onset of Alzheimer's disease years before a person shows symptoms. The study also includes cognitive evaluations to track the cognitive abilities of participants as a marker for Alzheimer's disease progression.

Andrew Alexander, PhD



Bradley Christian, PhD

ABC-DS is the next stage of another study, the Neurodegeneration in Aging Down Syndrome, where Christian and the Waisman Center were key players. "We are now at the next phase, where the number of study participants has continued to grow to enhance the significance of our findings. We are bringing in additional sites and including roughly 600 individuals [with Down syndrome]. Our goal is to prepare the way for participation in clinical or prevention trials for the treatment of Alzheimer's disease," Christian said.

ABC-DS Study Sites

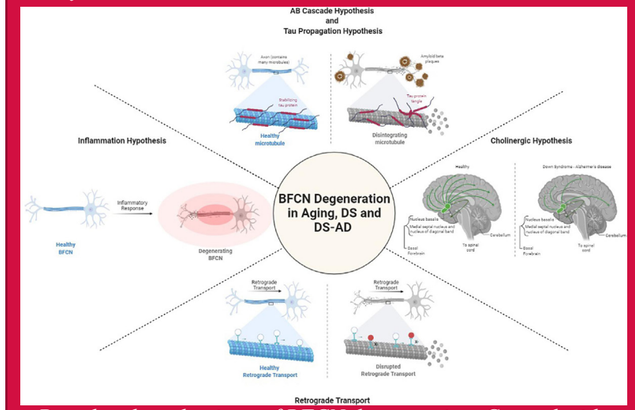
- **University of Pittsburgh**
  Pittsburgh, PA
- **Columbia University Irving Medical Center**
  New York, NY
- **The New York State Institute for Basic Research in Development Disabilities**
  Staten Island, NY
- **Harvard Medical School, Massachusetts General Hospital**
  Boston, MA
- **University of Wisconsin-Madison, Waisman Center**
  Madison, WI
- **University of Cambridge**
  Cambridge, UK
- **University of California, Irvine**
  Irvine, CA
- **University of Kentucky: Sanders-Brown Center on Aging and the Kentucky Neuroscience Institute**
  Lexington, KY
- **Washington University in St. Louis School of Medicine**
  St. Louis, MO

The ABC-DS study will last five years and collect a variety of data in 16-month cycles with the goal of understanding the relationship between Alzheimer's disease biomarkers and progression as well as how this information can be used to better inform the design of therapeutic clinical trials for both individuals with Down syndrome and the general population.

Christian would like to highlight the important contributions of Waisman Center collaborators Sigan Hartley, PhD, Andrew Alexander, PhD, Renee Makuch and the Wisconsin Alzheimer's Disease Research Center.

LINKING DOWN SYNDROME AND ALZHEIMER'S DISEASE

Down syndrome (DS, trisomy 21) is characterized by intellectual impairment at birth and Alzheimer's disease (AD) pathology in middle age. As individuals with DS age, their cognitive functions decline as they develop AD pathology. The susceptibility to degeneration of a subset of neurons, known as basal forebrain cholinergic neurons (BFCNs), in DS and AD is a critical link between cognitive impairment and neurodegeneration in both disorders. BFCNs are the primary source of cholinergic innervation to the cerebral cortex and hippocampus, as well as the amygdala. They play a critical role in the processing of information related to cognitive function and are directly engaged in regulating circuits of attention and memory throughout the lifespan. Given the importance of BFCNs in attention and memory, it is not surprising that these neurons contribute to dysfunctional neuronal circuitry in DS and are vulnerable in adults with DS and AD, where their degeneration leads to memory loss and disturbance in language. BFCNs are thus a relevant cell target for therapeutics for both DS and AD but, despite some success, efforts in this area have waned. There are gaps in our knowledge of BFCN vulnerability that preclude our ability to effectively design interventions. Here, we review the role of BFCN function and degeneration in AD and DS and identify under-studied aspects of BFCN biology. The current gaps in BFCN relevant imaging studies, therapeutics, and human models limit our insight into the mechanistic vulnerability of BFCNs in individuals with DS and AD.



Postulated mechanisms of BFCN degeneration. Created with BioRender.

Research at the University of Wisconsin-Madison has found that degeneration of cholinergic neurons in the basal forebrain is strongly correlated with cognitive function. It is not known what causes the degeneration of BFCNs. Several hypotheses have been raised to define the mechanisms underlying BFCN degeneration in DS and AD including those focused on acetylcholine, amyloid-β, tau, inflammation, and retrograde transport (Figure). Yet, gaps in our understanding of their role specifically in BFCNs remain.

The Big Cat Scan: Modern Radiology Meets An Extinct American Cheetah

By Emma Roberts, University Communications

David Lovelace, paleontoligist with the University of Wisconsin Geology Museum, positions the skull and fossil bones of a modern-day puma being prepared for computed tomography (CT) scans.

About 23,000 years ago, the Bighorn Mountains of Northern Wyoming resembled the landscape of today's African Sergeti plains.

The Miracinonyx, also known today as the extinct North American cheetah, roamed this region among mammoths, saber tooth tigers and even camels. Imagine an ancient Miracinonyx spotting a pronghorn antelope grazing on the ridge ahead and plotting its plan of attack, unaware that its path will take it through time to a lab at the University of Wisconsin–Madison, where researchers will turn to modern technology to see into the Miracinonyx's past.

The cat — a lithe 150 pounds, nearly 3 feet tall and twice as long — takes off down the ridge after the pronghorn as it begins to sprint in fear. The pronghorn is, at least in modern day, the second-fastest animal on the planet, so the Miracinonyx must be faster if it wants dinner tonight. But can it keep up? As predator and prey scurry in a high-speed chase, the Miracinonyx is snatched from the hunt when an abrupt 12- by 15-foot cave entrance appears beneath its feet. Before it can react, our Miracinonyx plummets 82 feet straight down to its death.

At the bottom of the pit, in a pile along with other unsuspecting creatures, the Miracinonyx rots down to the bone, until its complete skeleton is recovered among 40,000 other specimens millennia later by teams of paleontologists.

This unique land formation that took the life of this particular Miracinonyx and so many other creatures is now fittingly known as Natural Trap Cave. Since its discovery in the 1970s, Natural Trap Cave has become a hub for paleontology because of the sheer number of fossils that have been found there. Additionally, the conditions inside the cave are almost like a refrigerator — consistently no more than 42 degrees Fahrenheit with high humidity — making the site ideal for fossil preservation.

"Because it preserves genetic information in the fossil bones, we were able to use ancient DNA to really understand the ebb and flow of gene transfer between these very disparate (arctic and lower 48) populations, which is helping to understand migration patterns and how large populations of animals like horses, camels, and mammoth are affected," says David Lovelace, a paleontologist at the University of Wisconsin Geology Museum.

In the specific case of the Miracinonyx skeleton, scientists are using the bones to answer questions about the animal's behavior. Was Miracinonyx a runner like the African cheetah is today? Could a high-speed chase after the pronghorn antelope even be plausible? Evidence from isotope data gathered from the Miracinonyx's teeth proves that it did indeed consume pronghorn, but it cannot confirm that Miracinonyx hunted pronghorn. Could Miracinonyx have been the fastest mammal to have ever run across America's land?

In January, Lovelace and fellow paleontologists Aaron Kufner and Tony Hotchner entered the Wisconsin Institute for Medical Research's Imaging Services Department with boxes full of big cat bones. There, they met up with Ke Li, assistant professor of medical physics, and graduate student Dan Bushe. The team combined forces to make 3D scans of the Miracinonyx bones and two species of other big cat bones, the modern puma and modern cheetah, for the purpose of comparison to Miracinonyx.

The modern puma is the closest relative to Miracinonyx, based on mitochondrial DNA. The modern cheetah is also a close relative; it has an axial backbone which will be useful in comparing the Miracinonyx's utilization of dorsiflexion, the backward bending and contracting of the foot, and other similarities if Miracinonyx is indeed a runner.

Computed tomography (CT) scan operator and graduate student Dan Bushe reviews captured data of skull and fossil bones.

The CT scans, a type of X-ray typically used to get accurate cross-sections of human patients, should give evidence that either supports or negates the hypothesis that Miracinonyx was a runner. By using CT data, the researchers hope to look at one of the forearm bones, the radius, to see if it is locked more like a modern cheetah or more flexible like a modern puma. If locked, the Miracinonyx has the potential to be a runner; if not locked, the extinct cheetah may not have been as speedy as hypothesized.

The paleontologists also have other inquiries about the big cats that the CT scans will hopefully offer insight about. Lovelace and the group will use the information from the scan to plot data points on the animals' body shape and structure and observe differences between the three species.

This data will go into Dragonfly modeling software and quantitatively compare the curvature of the bones. Without imaging, it is difficult to distinguish the bones just by looking at them. More specifically, they want to view the internal brain cavity and cast the skulls, allowing comparison of cranial nerve placement and where nerves connect to stimulate the nose, eyes, and more.

Looking at this data can help reveal if Miracinonyx had a keen sense of smell or more visual acuity in comparison to the puma.

These projects ultimately contribute to the overall goal of "trying to understand the larger evolutionary history of these cats in North America," says Lovelace. "It's going to be complex. And it's going to be fun to try to tease apart using both what genetic information we have as well as morphological information to test various hypotheses on these partitioning, hunting strategies; and then comparing all of that with paleogeography (where and when the animals are found)."

While the cheetah is known to be fast, paleontology research is often extremely slow. Paleontology is an exciting avenue of discovering more about our history, the creatures around us, and their evolution; but don't hold your breath. Projects can take a while to complete, and describing a new species can take decades, according to Lovelace.

"I always feel bad," Lovelace notes. "'Yeah, hey! Let's collaborate…but it's going to be 10 years before we get a paper out.'"

The papers themselves are also lengthy, with his longest coming in at around 60 pages. For the Miracinonyx project, Lovelace hopes to have preliminary findings released within the year, but it will take several for official publications to come out.

However, the CT scan of all the bones — which are on loan from the University of Wisconsin Zoological Museum and the University of Kansas — took only a few hours to complete. CTs can be used for much more than just paleontology or to scan the human body.

In fact, this is not the first time Ke Li and the medical physics team have scanned a unique sample. A variety of industrial materials, cadavers, circuits, and tissue specimens, have all been scanned in the past, and special CTs have even been created to scan live animals.

Ke Li and the team at the Wisconsin Institute for Medical Research's Imaging Services Department want to raise awareness to this exceptional resource.

"This is really unique, this facility and scanner, because the majority of CTs are dedicated for research for clinical use and for clinical patient imaging," Li says. "We just hope around campus more users will notice the facility and the opportunity to get imaging non-invasively and get some research done here."

Alumni Spotlight

Jessica Fagerstrom, PhD ‘17

In March 2022, as part of a month-long Women’s Futures Month festival, the largest collection of statues of women ever assembled was installed on and around the National Mall and Smithsonian museums in Washington, DC.

The #IfThenSheCan – The Exhibit, featured 125 female STEM innovators selected by the American Association for the Advancement of Science (AAAS) and Lyda Hill Philanthropies. The 125 life-size 3D-printed statues represented a diverse coalition of contemporary women STEM innovators and role models leading a variety of fields, from protecting wildlife, discovering galaxies, building YouTube’s platform, to trying to cure cancer.

As part of this exhibit, the selected women serve as AAAS IF/THEN Ambassadors, all serving as high-profile role models for girls. The IF/THEN is an initiative of the Lyda Hill Philanthropies designed to activate a culture shift among young girls to open their eyes to STEM careers. From tagging sharks, searching for extraterrestrial life, fighting superbugs, to choreographing robots, these STEM innovators were selected through a rigorous process with a commitment to inspire the next generation.

Of the 125 women selected was Jessica Fagerstrom, Ph.D., alum of the University of Wisconsin-Madison’s Medical Physics Graduate Program. Fagerstrom earned her Ph.D. in Medical Physics from the University of Wisconsin-Madison in 2017, advised by Drs. Larry DeWerd and Wes Culberson. In 2021 she went on to earn a M.Ed. in Curriculum and Instruction with a specialization in Science Education from the University of Washington.

Currently Jessica works as a medical physicist at the Norwest Medical Physics Center in Seattle, Washington where she specializes in radiation therapy physics.

As a medical physicist, Fagerstrom’s priority is to make sure that the radiation cancer patients receive is delivered safely and effectively. “I love my job,” says Fagerstrom, “because I get to use fascinating science and cutting edge technology to help people who are sick to feel better.”

Dr. Fagerstrom enjoys volunteering with young students, encouraging the next generation to pursue a career path in medical physics (and other STEM professions). She also loves hiking, marathon running, and snorkeling with her husband, family, and friends.

Pictured at left is Jessica Fagerstrom, PhD with her 3D-printed statue that was part of the #IfThenSheCan - The Exhibit in Washington, DC from March 2022.

New Collaborative Research Center to Provide Clearer Image of Tumor Microenvironment

By Tom Ziemer, Department of Biomedical Engineering

Immunotherapies, in which care teams harness and augment patients' immune systems to battle diseases, have emerged as promising treatments for a range of cancers. Yet their effectiveness remains largely blunted in solid tumors—a roadblock that a group of biomedical engineers and cancer researchers from the University of Wisconsin-Madison and the University of Minnesota hope to overcome through a new research collaboration.

Kevin Eliceiri, an associate professor of biomedical engineering and medical physics at UW-Madison, and Paolo Provenzano, an associate professor of biomedical engineering at the University of Minnesota, will lead the Center for Multiparametric Imaging of Tumor Immune Microenvironments, funded by a five-year, $6.7 million grant from the National Cancer Institute.

The collaboration aims to inform new immunotherapy designs and strategies by developing, testing and deploying an integrated toolkit of imaging and data analysis technologies, shared across institutional lines. By applying advanced optical imaging, nano- and microfabrication and biophysical modeling techniques specifically to solid tumor microenvironments and studying how they influence immune function, Eliceiri hopes the team can unlock new solutions for therapies.

"We're realizing that the microenvironment matters a lot in cancer invasion and progression," says Eliceiri, a leader in developing imaging hardware and software for cell biology applications. "So instead of imaging that takes cells out of the natural context and puts them flat on glass, we want to look at environments that are more natural and we want to be more holistic in our imaging, where we track the microenvironment plus all the cell types, not just the cancer cells themselves."

The UW-Madison group, which also includes Professors Paul Campagnola of biomedical engineering and medical physics, and Melissa Skala of biomedical engineering, and Assistant Professor Suzanne Ponik from the Department of Cell and Regenerative Biology, will handle the technology development side of the project.

For Eliceiri's research group, that will include further developing a suite of machine-learning-based tools for studying the microenvironment; building hardware that allows for label-free imaging of fibers of collagen (a prevalent connective tissue component that plays a key role in cancer metastasis)

in commonly used pathologist's microscopes; and honing a system capable of measuring the dynamic "fingerprint" of metabolism in cancer cells. Skala will add her expertise in metabolic imaging techniques, while Campagnola has pioneered ways of translating collagen imaging to fabrication, allowing the group to 3D print biologically relevant scaffolds for therapeutic testing. Ponik, an expert in engineered and in vivo tumor microenvironment models, will help evaluate the new technologies.

Kevin Eliceiri, PhD

The UW-Madison researchers will then share their technology with the team at Minnesota, a group of 13 investigators who will test it all while studying glioblastoma, the most common form of brain cancer, and pancreatic cancer.

"We are extremely excited to launch this collaborative center and work to define physical and chemical barriers to effective antitumor immune response and immunotherapies using state-of-the-art imaging. The structure of this center is particularly satisfying, considering the longstanding collaborations between Kevin and me, and my history with the UW Department of Biomedical Engineering," says Provenzano, who in 2003 was the fifth student to graduate from UW-Madison's biomedical engineering PhD program.

The University of Wisconsin Carbone Cancer Center and the University of Minnesota Masonic Cancer Center are providing additional funding for the effort, which Eliceiri says will allow the center to connect with even more collaborators on both campuses.

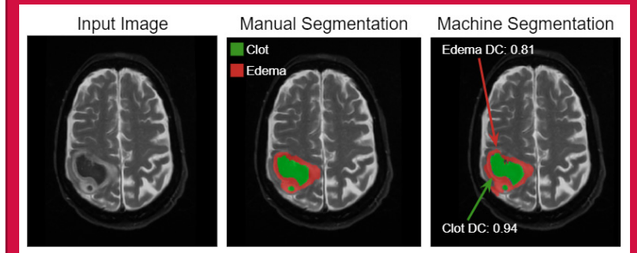
"We always want to advance the technologies available to our cancer research community," says Eliceiri. "By the end of the grant, our tools will be better, they'll be vetted by collaborative cancer biology projects, but also our tools will be present in Minnesota for continued use. Everyone's research goals are benefited this way. It's a very synergistic collaboration."

GRADUATE STUDENT HIGHLIGHT: THOMAS LILIEHOLM

Thomas Lilieholm

Graduate student, Tom Lilieholm joined the Department of Medical Physics in the fall of 2019, and has since been busy learning experimentation techniques and developing an understanding of the core medical physics curriculum.

Despite much of his graduate career taking place throughout the coronavirus pandemic, in fall of 2021, Tom was able to develop a new machine-learning approach that allows neurosurgeons to visualize clot volumes left during minimally invasive procedures. Improved image guidance is needed for neurosurgeons to reduce the residual remaining clot levels during minimally invasive evacuation of intracerebral hemorrhage (ICH) while not cuasing rebleeds. Neurosurgeons would benefit from a means to periodically render the clot volume against surrounding normaltissue during mechanical evacuation or pharmaceutical-based clot-busting.



Using convolutional neural networks (CNN), he created machine learning models to automatically segment the constituent clot and edema induced by ICH cases using T2-weighted MR images. The CNN's output results were found to be in agreement with manual segmentations of the same ICH cases.

Tom is currently in his third year of the medical physics graduate program, and is advised by Dr. Wally Block.

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X-ray Imaging & Therapy

Zaver Bhujwalla
Director, Div. Cancer Imaging Res, Dept. Radiology, Johns Hopkins U.
Molecular Imaging

Marvin Doyley
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Join us for this inaugural event!

Current faculty and staff, colleagues and alumni are encouraged to attend. Please visit www.medphysics.wisc.edu/emerging-leaders-symposium-and-workshops/ for more information.

Alumni & Friends Reception

Monday, July 11, 2022
8:00 - 11:00pm

Grand Hyatt Washington, Declaration AB Room
1000 H Street NW, Washington, DC

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We've missed you! Department alumni, faculty, students, and friends are invited to attend the UW-Madison Department of Medical Physics alumni reception. The reception will kick off with remarks from department leadership at 8:00PM (EDT).

Please RSVP to let us know you will be joining.

We Want to Hear from You

Please continue to send us your professional and personal news, including information about your honors, appointments, career advancements and other activities of interest. We'll include your news on our website and our next edition of the newsletter, as space allows. Please include names, dates and locations.

Photographs are encouraged.

Have you moved? Have a new email address? Please update your contact information.

Contact Information

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Faculty Spotlights

Sean Fain, PhD & John Vetter, PhD

Dr. Sean Fain retired from the University of Wisconsin-Madison in fall 2021, after a 20 year tenure with the Department of Medical Physics.

During his time with the department, Dr. Fain served as Vice Chair of Research for six years and was most recently an asset member of the department's curriculum transformation committee - leading the development of the imaging track curriculum within medical physics.

Over his career, Dr. Fain was an integral member of the Department of Medical Physics and campus as a whole. He will be deeply missed among those in the department, but we wish him the best in his new endeavors!

Dr. Fain now resides as Professor and Vice Chair for Research of the Department of Radiology at the University of Iowa.

Drs. Wally Block and Sean Fain at ISMRM 2022 conference, where Dr. Fain was named a 2022 ISMRM Fellow.

John Vetter, PhD

Dr. John Vetter has retired from the University of Wisconsin-Madison as of the end of June 2022. Dr. Vetter began his career with the Department of Medical Physics as a graduate student, receiving his PhD in medical physics in 1990. After completing his degree he was hired as a faculty member, and remained with the department for the duration of his career.

Dr. Vetter is most notable for directing the radiological physics services at the UW Hospital and Clinics, as well as serving as the associate director for the University of Wisconsin Imaging Physics Residency Program. His expertise will be deeply missed in the department.

(Pictured below) Medical Physics faculty gathered at the annual faculty retreat in June 2022 at the Memorial Union to strategically plan for the future of the department.

The Medical Physics Fund

The fund provides discretionary funding to the Department of Medical Physics Chair and is dedicated to provide financial assistance for the department's missions of teaching, research, and service. Examples of how such funds may be used include, but is not limited to, travel awards, research, and equipment.

The John Cameron Visiting Lectureship Fund

This fund is specifically dedicated to support the establishment and ongoing development of medical physics lectures and regularly held seminars. Examples of how such funds may be used include, but are not limited to, travel and honoraria for lecture speakers.

The Medical Physics Alumni Fellowship Fund

This fund is specifically dedicated to provide funds for a fellow in Medical Physics. The fellowship will provide supplemental funding for a post-graduate fellow in Medical Physics, thereby, allowing that fellow the opportunity to pursue areas of research and teaching in the field.

The Paul DeLuca, PhD Scholar Fund

This fund will support the broad educational and professional development of Medical Physics select graduate students giving them the freedom to pursue innovative projects wherever they may lead. This fund was formed in 2021 in honor of Emeritus Professor, Paul DeLuca.

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Department Chair: Brian Pogue, PhD
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