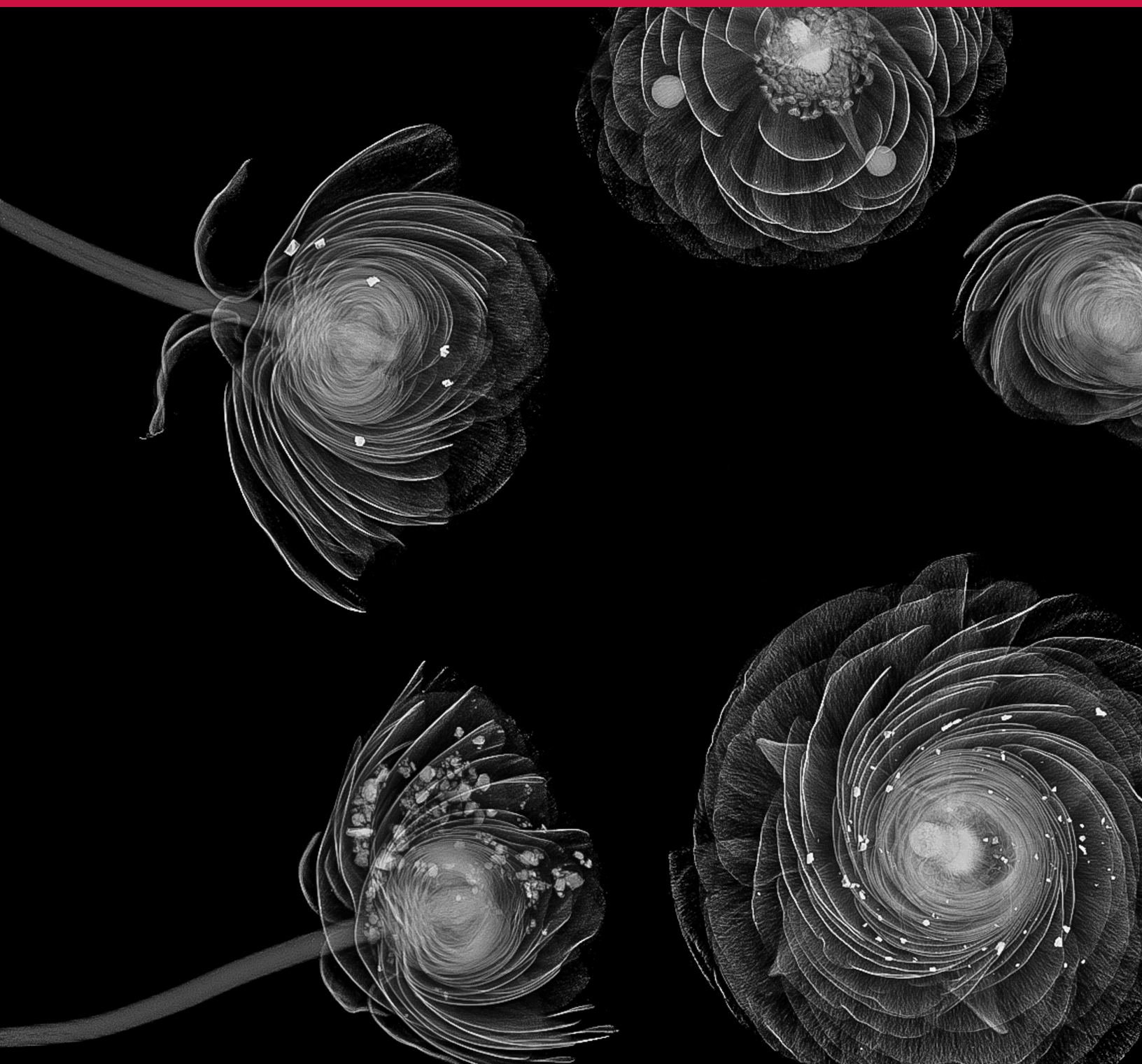
Summer 2020

Department of Medical Physics
UNIVERSITY OF WISCONSIN
SCHOOL OF MEDICINE AND PUBLIC HEALTH

The Medical Physicist



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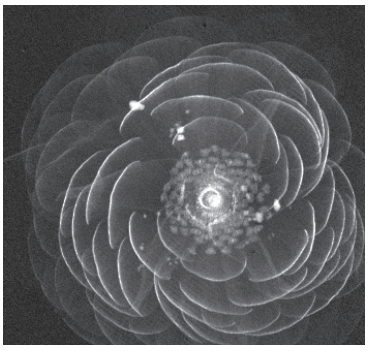


On the Cover

2020 UW Cool Science Image Award Winners

Images Courtesy of Ran Zhang and Dalton Griner

Zhang and Griner's photo submission was one of 12 winners in the 2020 UW-Madison Cool Science Images contest. More information on the research connected to this photo can be found on Page 4.

In Memoriam
Remembering Edward Jackson

Edward "Ed" Jackson, who stepped down as Chair of the Department of Medical Physics this past December, passed away Tuesday, June 2, 2020. Ed had been a highly effective and impactful leader in the School of Medicine and Public Health since 2013, when we were fortunate enough to recruit him to serve as Chair of the Department of Medical Physics. He was a tireless advocate for science, education, and the Wisconsin Idea.

Prior to joining SMPH, Ed was a faculty member at the University of Texas MD Anderson Cancer Center. During his time with us, he led our Department of Medical Physics through a period of innovation and growth that included revamping the department's graduate program in a visionary way that secured its position as one of the best in the nation. His commitment to excellence, diversity, and collaboration reflected and advanced the very best traditions of our institution.

He received his BS (1984) and MS (1986) in Physics from Auburn University and completed his PhD in Biophysics from the University of Texas Health Science Center at Houston Graduate School of Biomedical Sciences in 1990. He began his career at MD Anderson Cancer Center in Houston, TX and ended with his chairmanship of the University of Wisconsin School of Medicine and Public Health, Department of Medical Physics.

His professional focus was on the use of Magnetic Resonance Imaging to further the treatment and understanding of cancer. Throughout Ed's career, the education of future medical physicists was of paramount importance to him as he taught and developed many courses in this area. This career allowed him to meet many diverse people and see exciting parts of the world, both of which were important to him.

Ed and medical physics students participated in The Ride: A Bicycle Benefit for Cancer Research in 2019.

Throughout his career, Ed made remarkable contributions to our school and to the world of medical physics. He gracefully balanced the fulfillment of his leadership roles here and at national organizations with his ongoing engagement in cutting-edge research and individual mentorship. He will be remembered as a true force for good.

Ed was a strong believer in academia and education. If you are looking for a way to further his legacy, consider making a donation to the Medical Physics Fund in his name.

Please also consider joining us for a virtual "Celebration of Life" on July 22, 2020 at 8:30AM CST. Details to join this virtual celebration will be posted on the department website: *www.medphysics.wisc.edu*

Greetings From the Interim Chair

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

On behalf of the entire department, I am pleased to announce the most recent edition of the Department of Medical Physics Newsletter. As highlighted in this edition, the past year has been a busy one, with continued transitions in personnel, numerous research and education initiatives, and unexpected changes such as the sudden shift to remote instruction and research due to the coronavirus pandemic (read more on Page 17). I am extremely proud of our researchers and staff for their fortitude during these unprecedented times. Their efforts continue to ensure the department remains at the forefront of medical physics research, education and training.

I also want to take this opportunity to acknowledge the pain that Black people in the United States have been experiencing for centuries. 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. My hope for the department is that we further our commitment to diversity and inclusion and reduce racial inequalities throughout our community.

To that end, this year the Department of Medical Physics is renewing its commitment to diversity and inclusion. This summer, the graduate-student led Committee for Recognizing Equity, Diversity and Inclusion in Medical Physics (REDI) is hosting town hall meetings to engage students, staff and faculty in conversations about inclusion in STEM. It is REDI's goal to continue these open conversations throughout the next academic year and to reform department policies such that policies actively promote diversity and inclusion. We will also be dedicating increased effort to expand our understanding of diversity, unconscious biases and allyship, specifically in medical physics, and how these inform our recruitment and retention of graduate students and faculty today and in the future. Continued learning is crucial for this progress, and I intend to implement strategies that ensure we all continue to grow and effect positive change.

With regard to philanthropy, I want to 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 24 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 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 (see Page 23).

Finally, I want to again express my sincere appreciation to all active and past faculty, staff, students and residents, post-doctoral fellows, and scientists who establish, and maintain, the reputation of the Department of Medical Physics as a leader in innovative research, education, and service.

It is a deep honor and privilege to serve as Interim Chair of such a phenomenal department. While I am immensely proud of achievements past and present, I firmly believe the future of this department is even brighter.

On, Wisconsin!

Timothy J. Hall, PhD

2019 - 2020 Awards and Honors

Spring 2020

Paul Campagnola - Received 2020-21 Kellett Mid-Career Award.

Ian Marsh - Received 2020 American College of Radiology Medical Physics Graduate Student Travel Scholarship to attend the ACR Annual Meeting next summer.

Catherine Steffel - Won Best in Physics Oral Presentation for the 2020 Joint AAPM/COMP Meeting.

Lindsay Bodart - Finalist in the John Cameron Young Investigator Symposium for the 2020 Joint AAPM/COMP Meeting.

Evan Harvey - Won Best in Physics (Imaging) award for the 2020 Joint AAPM/COMP Meeting.

Ran Zhang and Dalton Griner - Winners of the UW 2020 Cool Science Images Contest.

Leo Steiner - Received a 2020-21 Hilldale Undergraduate/Faculty Research Fellowship.

Frank Ranallo - Promotion to Professor (CHS) approved by SMPH effective July 1, 2020.

Paul Campagnola - American Institute for Medical and Biological Engineering Class of 2020.

Ian Marsh - Society of Nuclear Medicine and Molecular Imaging recipient of the Alavi-Mandell Award.

Catherine Steffel - Winner of the 2020 American Association for the Advancement of Science Student E-Poster Competition.

Xu Ji - Received second place for SPIE Robert F. Wagner Best Paper Award; first place from Physics of Medical Imaging.

Wesley Culberson - Promotion to Associate Professor (CHS) approved by SMPH effective July 1, 2020.

Tomy Varghese - Received Office of the Vice Chancellor for Research and Graduate Education Fall Competition award.

Catherine Steffel - Received the 2020 Joshua E. Neimark Memorial Travel Assistance Award.

Kevin Eliceiri - Selected as a Vilas Associate.

Fall 2019

Beth Meyerand - Received 2019 Slesinger Award for Excellence in Mentoring.

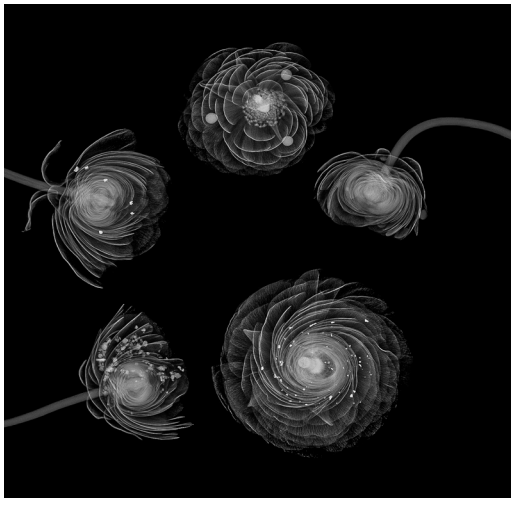
Kevin Eliceiri - Received Chan Zuckerberg Initiative Award.

Kaelyn Seeley and Chris Kutyreff - Received UW Student Research Competition Awards.

Beth Meyerand - Elected to serve three-year term on the Academic Planning Council.

Jonathan Engle - Recipient of a Presidential Early Career Award for Scientists and Engineers.

To read more about these honors and awards, please visit our website.



2020 UW Cool Science Image Award Winners

Images Courtesy of **Ran Zhang, PhD** and **Dalton Griner, MS**

A new imaging modality called x-ray grating-based multi-contrast mammography is being developed in the research group of **Guang-Hong Chen, PhD** to distinguish between different types of microcalcifications that can indicate cancer or precancerous changes in breast tissue. This imaging technique uses grating interferometers to measure x-ray refraction (phase contrast image) and scattering (dark-field image) rather than simply the extent to which a tissue absorbs x-rays. Zhang and Griner, members of Chen's lab, used their novel imaging system to acquire these award-winning images of flowers, which simulate adipose tissue in the breast, and embedded calcifications.

Professor Will Make 'Workhorse' Microscope More Powerful

By Natasha Kassulke, University Communications

Kevin Eliceiri, professor of medical physics and biomedical engineering at the University of Wisconsin–Madison, plans to improve the architecture and infrastructure of µManager, an open-source software package for control of automated microscopes.

Open-source software is crucial to modern scientific research for advancing biology and medicine while also providing reproducibility and transparency. Yet, even the most widely used research software often lacks dedicated funding.

Now, Eliceiri received a $200,000 grant for his work from the Chan Zuckerberg Initiative. CZI awarded just 32 grants worldwide for 42 such projects.

"This project is all about making the workhorse known as the microscope more powerful," says Eliceiri, a principal investigator in the Laboratory for Cell and Molecular Biology in the Office of the Vice Chancellor for Research and Graduate Education, associate director of the McPherson Eye Research Institute, and investigator of the Morgridge Institute for Research.

"Open-source software not only enables unhindered adoption but importantly free adaptation, taking tools into new directions beyond their original intent."

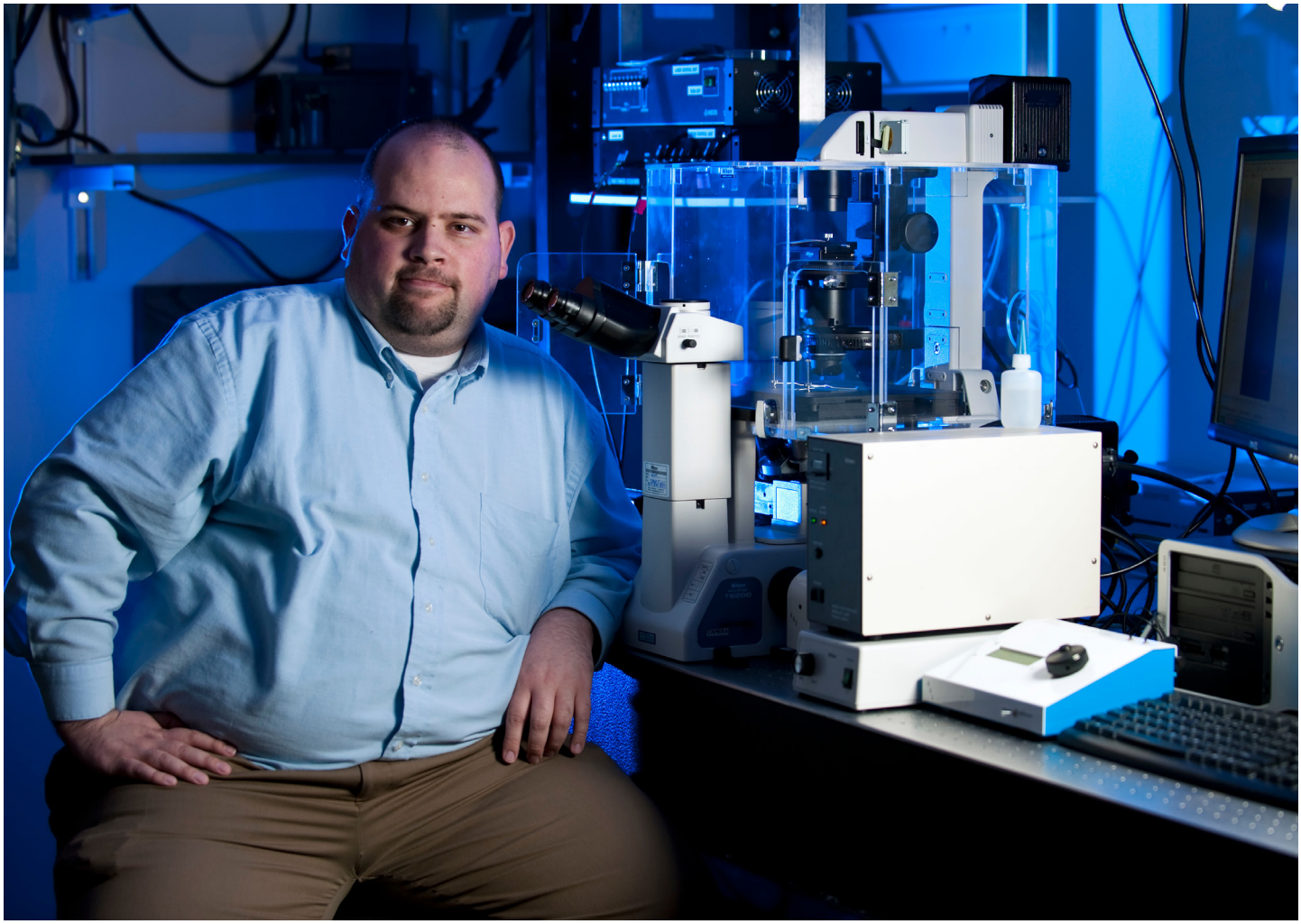
Eliceiri uses µManager in his own research, which focuses on biophotonics, or the use of light to investigate biological phenomena, and on the application of computational techniques to analyze and process images of biological processes in real time.

> ***"Not only can open-source software save time and resources, but it can directly lead to new innovation and discovery."***
>
> **- Kevin Eliceiri**

Much of this informatics work entails development of the widely used open-source ImageJ software. µManager heavily relies on ImageJ for its functionality and Eliceiri's CZI funding benefits both software packages.

"Software allows you to work with the full lifecycle of data — how you acquire data, visualize it, analyze it — and open-source software is all about accessibility and transparency, allowing scientists to freely try new approaches and understand precisely what was done in a study," Eliceiri says.

The CZI grant will also lead to enhanced data acquisition using µManager.



Kevin Eliceiri works with a swept-field confocal microscope. "This project is all about making the workhorse known as the microscope more powerful," says Eliceiri, a principal investigator in the Laboratory for Cell and Molecular Biology.

"When one thinks of how data is acquired, that often doesn't get as much attention as data analysis," Eliceiri says. "I'm interested in optimizing the settings of the microscope and improving how the hardware are talking to each other."

Eliceiri is using these tools to understand the role that the environment within a cell plays in disease progression.

"Optical imaging is the tool of choice for understanding cellular phenomena with precise spatial and temporal accuracy," he adds.

Eliceiri says he has always believed that science is best done by building on the work of others and openly sharing what you have done.

"Open-source software is the very embodiment of this concept," he says. "Not only can open-source software save time and resources, but it can directly lead to new innovation and discovery."

Founded by Dr. Priscilla Chan and Mark Zuckerberg in 2015, CZI leverages technology to help solve some of the world's toughest challenges, from eradicating disease to improving education and reforming the criminal justice system.

Other CZI funded projects include tools for visualizing, analyzing and managing data for research areas such as genomics, structural biology, cell biology, neuroscience and more.

Graduate Class of 2020

PhD Degree

Muhammed Bedir, PhD
Advisor: Bruce Thomadsen, PhD

Lianna DiMaso, PhD
Advisor: Larry DeWerd, PhD

Evan Harvey, PhD
Advisor: Guang-Hong Chen, PhD

Xu Ji, PhD
Advisor: Guang-Hong Chen, PhD

Michael Pinkert, PhD
Advisor: Kevin Eliceiri, PhD

Amy Weisman, PhD
Advisor: Robert Jeraj, PhD

Master's Degree

Alexander Kaeck, MS
Advisor: Alan McMillan, PhD

Imaging Physics Residency Program

In June 2020, **Megan Lipford, PhD** and **Sean Rose, PhD** completed their two-year, CAMPEP-accredited imaging physics residency at UW-Madison. Lipford accepted a position as an Assistant Professor of the Department of Radiology at Wake Forest School of Medicine. Rose will remain on the UW-Madison campus for the next year to continue research as a post-doctoral researcher. During their residency both Lipford and Rose presented at AAPM, RSNA and within the UW Health community on various topics, including motion artifacts in pediatric body CT and how these vary with scan speed and patient age.

Megan Lipford, PhD

Sean Rose, PhD

Residency Open House

The department invited eight prospective imaging residents to the third Medical Physics Imaging Residency Program Open House. The open house, which took place over two days in mid-February, was a whirlwind of Q&A sessions, presentations, tours, and interviews. Prospective residents enjoyed dinner at Cafe Hollander, and they also had the opportunity to talk to current residents about the program.

Two new residents, **Jordan Krebs, PhD** and **Joseph Meier, PhD,** began their residencies this summer. Krebs comes to the department from the University of Buffalo (SUNY) and Meier from the University of Texas MD Anderson Cancer Center. Please join us in welcoming them to the program!

The University of Wisconsin Medical Imaging Physics Residency program is a two year, CAMPEP-accredited training program that prepares two post-graduate medical physicists to perform independently as clinical medical imaging physicists. John Vetter, PhD, Director of Radiological Physics Services, and Frank Ranallo, PhD, Director of the Medical Imaging Residency Program, are integral to the operation and success of the imaging residency program.

Student Outreach

The Medical Physics Graduate Student Outreach program aims to increase the visibility of medical physics by teaching community members about the role of physics in medicine as well as the educational and career opportunities in physics-based careers. Our focus is directed to the next generation of curious thinkers, especially under-represented groups in medical physics, by engaging them in conversation and hands-on medical physics activities. This past year, our students clocked in over 50 hours of volunteering at outreach events in our community.

Before the start of the school year, three La Follette High School teachers visited the department to learn more about the role of physics in medicine so they could better incorporate concepts into their curriculum in the upcoming year. Graduate students and faculty led the teachers through four stations focusing on MRI, ultrasound, radiation therapy, and radiation measurement.

During the fall semester, graduate students participated in three events hosted at Madison elementary schools, focusing on hands-on activities for students to learn the many research areas of the department. Hundreds of students at Lake View, Schenk and Stephens Elementary schools enjoyed activities like guessing the body part shown in MR images and looking inside a gummy bear phantom with ultrasound, as well as learning about the plethora of research being done on campus by the department.

Unfortunately, the outreach service year was cut short by the coronavirus pandemic, but volunteers are excited and hopeful to get back out into the community soon and share their knowledge.

Recognizing Equity, Diversity, and Inclusion

The graduate student-led Committee for Recognizing Equity, Diversity, and Inclusion in Medical Physics (REDI) hosted an "Ask Me Anything" coffee hour with committee mentor and newly appointed Mentoring, Diversity, and Strategic Collaborations Chair **Beth Meyerand, PhD** in fall 2019. Later that semester, REDI hosted an important conversation on allyship, discussing what "being an ally" means at home and in the workplace and how each person can become a better ally. REDI's year was also cut short by the coronavirus pandemic, so spring events, including a planned seminar with **Heather Whitney, PhD,** Associate Professor of Wheaton College and Visiting Scholar with the Department of Radiology at the University of Chicago, were postponed.

In summer 2020, REDI hosted a virtual Town Hall to have an open and honest discussion around equality and racism in medical physics, identify ways in which individuals can educate themselves and become advocates for marginalized peers, and begin to develop a plan for the department and research groups moving forward. REDI will continue to host regular town halls and will be guiding new policies to foster inclusion in medical physics. REDI encourages any student or faculty who would like to get involved or nominate a member of the medical physics community to participate in REDI's Seminar Speaker program to please e-mail *redi@g-groups.wisc.edu.*

2019 Degree Dash

The Department of Medical Physics welcomed eleven new graduate students this past August for a five day orientation experience. Students were introduced to members of the faculty and admin team. Department members participated in the Graduate School 'Degree Dash' 10K run/walk around campus at the end of orientation week. The admin team manned a water station on the race route and cheered on the hundreds of runners, many of whom were our own students and staff!

Fall Picnic

The Annual Fall Picnic marks the beginning of the year for Medical Physics. Held at Rennebohm Park, a stone's throw away from WIMR, on Thursday, September 5, 2019, the picnic was a perfect way to ease into the school year for all returning students, faculty and staff. Despite having to contend with a Packer game the same night, more than half the department showed up to enjoy a beautiful late summer evening.

Our student reps (**Dan Seiter, MS, Autumn Walter, MS, Cole Cook, MS** and **Reed Kolany, MS)** were superb grill masters yet again. Thank you to everyone who participated, cooked, contributed to the picnic fund, and simply showed up to have a good time!

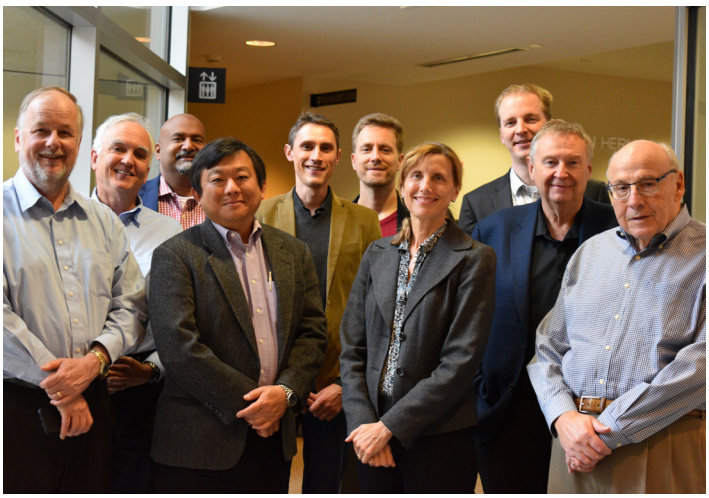
Bowl-o-Rama

Medical Physics' annual Bowl-o-Rama, held on Sunday, November 17, 2019 at Dream Lanes, was a resounding success this year. There were a whopping thirty five participants, consisting of students, faculty, and administrative staff.

Board of Visitors Meeting

The Department of Medical Physics Board of Visitors met again November 3-4, 2019 in Madison. Board members flew in from all parts of the country to discuss philanthropy and internship opportunities for students and the future growth of the Medical Physics department at UW-Madison.

The Board of Visitors had its inaugural meeting in 2018, and has been led by **Paul DeLuca, PhD** (Chair) and **Thomas "Rock" Mackie, PhD** (Vice Chair).



Prospective students enjoyed a tour of campus and downtown Madison during the 2020 Graduate Open House.

2020 Graduate Student Open House

We held one of the department's earliest Graduate Program Open Houses January 31 through February 1, 2020. Thirty-three students from across the United States and beyond came to learn what the Department of Medical Physics and the City of Madison have to offer. In addition to the student representatives and the department's admin staff, there were forty student volunteers to help ferry the prospective graduate students from interview to interview, and to drive around town.

Prospective graduate students met the student reps and some of the admin staff, were welcomed by **Tim Hall, PhD,** Interim Department Chair, went on tours of the Cyclotron and Calibration labs along with the Human Oncology and Radiology facilities, and listened to a presentation on the Outreach Program and the Committee on Recognizing Equity, Diversity and Inclusion in Medical Physics all before enjoying dinner at the Avenue Club on East Washington Ave – a Madison staple!

As if their first day wasn't busy enough, the prospective graduate students were in for a day of interviews with faculty the following day. Bunky's Catering provided the Mediterranean feast that carried students through the afternoon of interviews and presentations. As a way of getting to meet faculty, staff and students in a more relaxed environment, the prospective graduate students enjoyed a reception and hors d'oeuvres with faculty and current students and took a well-earned breather.

To end their visit, on their last day in Madison, prospective students enjoyed a low key brunch at Canteen – a popular Mexican eatery on Hamilton St, kitty corner from the Capitol building – followed by a tour of the Capitol and downtown Madison. This was a truly enjoyable and successful weekend for everyone involved, and everyone in the department always works hard to make it possible. Thanks to the students who visited and the faculty, students, and staff who made it happen!

Student Spotlight

Lindsay Bodart: BTP Helps Trainee Navigate Patent Application to Protect Research Invention

By Cheri Stephens, The UW-Madison Biotechnology Training Program

Biotechnology Training Program (BTP) trainee Lindsay Bodart first learned about patents and intellectual property in her Foundations of Biotechnology course at the start of graduate school. Little did she know that a few years later, she'd be filing a patent on a tool she created to help in her research.

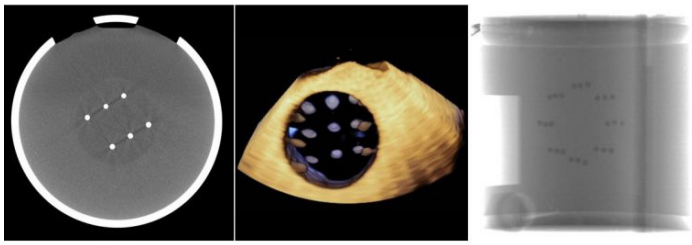
"I knew what a patent was, but that class was really where we started talking about topics like intellectual property, how and why to file patents, and starting a business," Bodart explains. "That was where I learned how our research could be used not just for advancement in academia but also in industry and other contexts. It started to connect those dots for me."

As a PhD student in the UW–Madison Department of Medical Physics, Bodart is part of the lab of BTP mentor and Professor Michael Speidel, which works to develop novel imaging technologies that can be used to help guide interventional procedures. One of their focuses is on cardiac interventions, surgeries that help repair valves or chambers of the heart.

Bodart specifically works on a problem physicians face when guiding catheters or other minimally-invasive devices through the blood vessels. Right now, they must look at two screens, one that has the x-ray image of the chest and another that displays ultrasound images of the heart, in order to navigate the catheter to where it needs to go in the heart. Both image displays have different benefits — x-ray images objects like bone and catheters clearly, while ultrasound captures soft tissues and organ structures — but researchers like Bodart believe there's a better way to present this to surgeons.

"The idea behind my research is to actually take those two images during the procedure and register them into one coherent display," she explains. "That would help the physician performing the procedure as they'll be able to see where the device is relative to the anatomy directly, rather than having to glean information from two completely separate displays."

To work toward this goal, she needed a way to test her ideas on how to combine the displays. Repeated x-rays would be too much radiation for a human volunteer or patient so she devised a piece of hardware called a "phantom." It's an object that can be used to mimic the properties of the human body in imaging. The phantom is an object that's in the shape of a big cylinder, about the size of the human thorax. They insert different columns into the phantom and also fill it with a slurry-like substance consisting of small pieces of graphite and agar. This allows it to mimic human tissue in imaging.



Shots of the phantom's interior using different imaging modalities. In each you can see the targets embedded within the phantom.

"We can then embed objects into each insert that can be visualized with both x-ray and ultrasound," says Bodart, who is in the fourth year of her PhD. "We can use a registration algorithm and visually see how it performs. We then generate a registration error metric that allows us to measure how well it is performing compared to other experiments and other methods."

Bodart and her advisor soon realized their tool wasn't just useful in their research but could also be used to train physicians in performing these kinds of heart procedures. It was then that they decided to try to patent their technology and reached out to the Wisconsin Alumni Research Foundation (WARF). WARF worked to get more information from them and then worked with a patent attorney to write a patent. They submitted it in the summer of 2019 and are waiting to hear from the United States Patent and Trademark Office on its status.

Cells Carrying Parkinson's Mutation Could Lead to New Model for Studying Disease

By Chris Barncard, University Communications

Marina Emorg, PhD

Parkinson's disease researchers have used gene-editing tools to introduce the disorder's most common genetic mutation into marmoset monkey stem cells and to successfully tamp down cellular chemistry that often goes awry in Parkinson's patients.

The edited cells are a step toward studying the degenerative neurological disorder in a primate model, which has proven elusive. Parkinson's, which affects more than 10 million people worldwide, progressively degrades the nervous system, causing characteristic tremors, dangerous loss of muscle control, cardiac and gastrointestinal dysfunction and other issues.

"We know now how to insert a single mutation, a point mutation, into the marmoset stem cell," says Marina Emborg, professor of medical physics and leader of University of Wisconsin–Madison scientists who published their findings Feb. 26 in the journal Scientific Reports. "This is an exquisite model of Parkinson's. For testing therapies, this is the perfect platform."

The researchers used a version of the gene-editing technology CRISPR to change a single nucleotide — one molecule among more than 2.8 billion pairs of them found in a common marmoset's DNA — in the cells' genetic code and give them a mutation called G2019S.

In human Parkinson's patients, the mutation causes abnormal over-activity of an enzyme, a kinase called LRRK2, involved in a cell's metabolism. Other gene-editing studies have employed methods in which the cells produced both normal and mutated enzymes at the same time. The new study is the first to result in cells that make only enzymes with the G2019S mutation, which makes it easier to study what role this mutation plays in the disease.

"The metabolism inside our stem cells with the mutation was not as efficient as a normal cell, just as we see in Parkinson's," says Emborg, whose work is supported by the National Institutes of Health. "Our cells had a shorter life in a dish. And when they were exposed to oxidative stress, they were less resilient to that."

The mutated cells shared another shortcoming of Parkinson's: lackluster connections to other cells. Stem cells are an especially powerful research tool because they can develop into many different types of cells found throughout the body. When the researchers spurred their mutated stem cells to differentiate into neurons, they developed fewer branches to connect and communicate with neighboring neurons.

"We can see the impact of these mutations on the cells in the dish, and that gives us a glimpse of what we could see if we used the same genetic principles to introduce the mutation into a marmoset," says Jenna Kropp Schmidt, a Wisconsin National Primate Research Center scientist and co-author of the study. "A precisely genetically-modified monkey would allow us to monitor disease progression and test new therapeutics to affect the course of the disease."

The concept has applications in research beyond Parkinson's.

"We can use some of the same genetic techniques and apply it to create other primate models of human diseases," Schmidt says.

The researchers also used marmoset stem cells to test a genetic treatment for Parkinson's. They shortened part of a gene to block LRRK2 production, which made positive changes in cellular metabolism.

"We found no differences in viability between the cells with the truncated kinase and normal cells, which is a big thing. And when we made neurons from these cells, we actually found an increased number of branches," Emborg says. "This kinase gene target is a good candidate to explore as a potential Parkinson's therapy."

Stephanie Harmon, PhD ’16

Stephanie Harmon, PhD

Stephanie Harmon, PhD ’16, is a staff scientist at the National Cancer Institute (NCI), the largest funder of cancer research in the world. While at UW-Madison, Harmon examined quantitative imaging biomarkers in lung and prostate cancers using PET/CT. As part of this work, she worked with an interdisciplinary team to clinically validate automated image processing tools being developed in the research group of **Robert Jeraj, PhD**. After graduating, she joined Leidos Biomedical Research, a contractor to NCI, as a postdoctoral scientist, and earlier this summer, she moved into a new and exciting role at NCI. **Catherine Steffel, MS ’17** sat down with Harmon for a virtual conversation about life before, during and after UW-Madison.

What first got you interested in science?
My grandfather was a high school physics and chemistry teacher, and my father has a degree in computer science. I guess I’m a mash of those two.

What has influenced your work in science the most?
On a personal level, I, like most of us, have been affected by the loss of several family members and friends to cancer. It’s fulfilling for me to be working in such a translational field. From a scientific perspective, I had a great undergraduate research adviser, **Konstantinos Arfanakis, PhD ’02,** who is an alum of the UW-Madison Medical Physics program and really helped shape my path. When I got into the program at Madison, he said, “There’s no way you should go anywhere else – you have to go there!”

What have you been working on since you finished your PhD?
Right after I finished my PhD, I moved out to Washington, DC. I essentially entered a postdoctoral scientist position in the government that I found through the National Institute of Health's graduate student recruiting program. During the first part of my postdoc, I continued in similar PET/CT research to what I had started while I was a graduate student. During the second half of my postdoc, I transitioned into working more with MRI in localized prostate cancer and its relation to histopathological imaging. Both involved developing artificial intelligence (AI) algorithms for image analysis. Now, I'm still heavily involved in clinical imaging research, but more on the level of assisting other fellows or maybe writing a few tools here and there. My heavy research focus is on digital pathology, and I just started a more permanent scientist role.

What does your new scientist role involve?
I am co-leading a new group called the Artificial Intelligence Resource within the Molecular Imaging Program at NCI. We offer AI-based solutions for researchers across NCI who have specific interests in clinical imaging, especially radiology and pathology. It's an interesting time to start a new group because of the pandemic, but we will have three senior-level staff, like myself, and eight fellows working with us at any given time. Right now, we work a lot in prostate cancer but eventually we want to branch out to all specialities within NCI and to any external collaborators who are interested in participating.

What do you like most about your job?
One of the things I like most about my job is how interdisciplinary it is. I work with computer scientists, medical students, clinical fellows, radiologists, technologists, and more. We come at an issue from different perspectives depending on our specialty, and the way we solve problems is different. All of that is really fascinating.

Have your career goals changed at all since you were a graduate student?
As a graduate student, I had the pipe dream that I would have the perfect balance of clinical and research responsibilities after my PhD. Even though I eventually decided I wanted to have an academic research career without any clinical responsibilities, I was intimidated by the tenure process. At one point, I wondered if I would end up transitioning into industry. But I found that there's a lot of different ways you can make an impact in academic research. As a scientist at NCI, I'm able to maintain independent research, and if I want to go on to an academic research role outside of the government, I like to think I still have the relevant experience that comes from grant writing –albeit more limited options in government –and mentoring students, that type of thing.

What did you find most valuable about completing your PhD at UW-Madison?
One of the great things about UW-Madison is that, for example, you can have flexibility in the courses that you take. Courses I took and projects I worked on that were more in the data science realm were extremely helpful for me during my postdoc, even if they didn't end up in my final dissertation, and that that is something that I highly encourage students to do.

Is there anything that you did during grad school that you're especially proud of?
I helped kickstart the AAPM's Working Group on Student and Trainee Research. We started the Expanding Horizons Travel award, which helps supplement students who want to branch into different fields as they work on their research. I'm so proud because the group has grown into something way more awesome than I could have imagined – it's cool to see that it's still going.

What is something your co-workers or UW-Madison colleagues may not know about you?
My favorite place to get away is Portland, Maine! My husband and I try to go once a year.

Do you have any advice for current medical physics students at UW-Madison?
My advice is to pursue as much as you can, whatever you're passionate about, as much as you're able to. Grad school is tough. Some of your projects won't end up in your thesis, but you have flexibility at UW-Madison to do so many different things. Take advantage of this while you can. And also know that there's a lot of opportunities if you're interested in a research career, including postdocs outside of traditional academia, like in industry and in the government.

Pandemic Pandemonium

How faculty, staff and students in the Department of Medical Physics adapted to the coronavirus pandemic

Wisconsin Governor Tony Evers declared a public health emergency on March 12, 2020 as a response to new cases of COVID-19, the disease caused by the SARS-CoV-2, and additionally called for the closing of all K-12 public schools in the state. As the UW's spring break approached, Chancellor Becky Blank urged instructors to prepare for online instruction and the inevitable that was on the horizon. Soon, all face-to-face university functions were canceled or moved online for the rest of the spring semester and summer semester, halting what seemed to be everything familiar to our everyday lives. Governor Evers later extended his Safer-at-Home order through May 26, 2020.

Department of Medical Physics instructors quickly moved all of their courses online, and research continued as best it could while away from lab spaces. Courses continued online as planned with the understanding that this was new territory for everyone - professors included! A huge kudos to faculty, staff and students for their patience during these unprecedented times and for sucessfully completing the spring semester.

The end of May 2020 marked the beginning of a return to campus for research purposes. Research began in phases, with a focus on expanding research activities while minimizing the risk of transmitting the coronavirus to students, staff, faculty and the community. The Chancellor in late June announced plans to welcome students back to campus in the fall for in-person instruction with some modifications to ensure the safety of the Badger community.

Defending While Safer-at-Home

Amy Weisman, PhD defended her work to receive her degree via video conference call. When asked what it was like to defend during the Safer-at-Home order and university shutdown, she said:

"It was an extremely surreal experience. I never would have guessed that I would defend my thesis without seeing my labmates in person for an entire month! Having been at home for a month, all of my practices were virtual and I had been able to test the Zoom set-up, which helped me become more comfortable with the virtual format. I learned that recording my practices and watching them back really helped figure out where I wasn't being clear and where I was spending too much/too little time, which is something that I think would help even for non-virtual defenses. The defense itself was actually pretty enjoyable. Not having to wear shoes was pretty nice, and seeing professors in their homes made it a much less intimidating environment."

COVID-19 Research in Medical Physics

Guang-Hong Chen, PhD was awarded a grant by the Wisconsin Partnership Program to research alternative means to diagnose coronavirus-related pneumonia. This research will look to improve accuracy of identification of coronavirus pneumonia on routine chest radiographs. The Wisconsin Partnership Program at the UW School of Medicine and Public Health awarded 22 new awards totaling $2.7 million to researchers and community organizations across Wisconsin for their efforts to lessen the impact of the coronavirus.

UW-Madison Brain Scan Studies Seek to Pinpoint Signs of Alzheimer's

By David Wahlberg, The Wisconsin State Journal
Photography By Steve Apps and Amber Arnold

Every weekday, a steel machine inside the concrete vault basement of a research building near UW Hospital produces radioactive atoms used to detect signs of Alzheimer's disease.

The atoms, some with short half-lives, are rushed in lead containers to the nearby Waisman Center, where in a lab they are attached to drugs. The drugs, or tracers, are injected into study volunteers as they undergo PET scans of their brains.

One tracer binds to amyloid, a sticky protein associated with Alzheimer's that forms plaques between brain cells, disrupting their function.

Another tracer attaches to an Alzheimer's-related protein called tau, which creates tangles inside brain cells, blocking communication between the cells.

A third compound sticks to synapses, the points where brain cells exchange information.

The scans, given mostly to healthy middle-age people with a family history of Alzheimer's disease, could help UW-Madison researchers answer key questions facing dementia research today: Why have drugs that clear amyloid from the brain failed to stop Alzheimer's? Why do some people with plaques and tangles develop dementia and others don't? What else might be contributing to the disease?

The scans "can show a signal maybe 20 years or so before symptoms appear," said Sterling Johnson, a neuropsychologist who heads the university's Wisconsin Registry for Alzheimer's Prevention, or WRAP. It's a study of nearly 1,600 people, most with a family history of the disease.

With more people receiving a variety of scans, data from the images is "going to accelerate research in ways we couldn't have imagined 10 years ago," Johnson said.

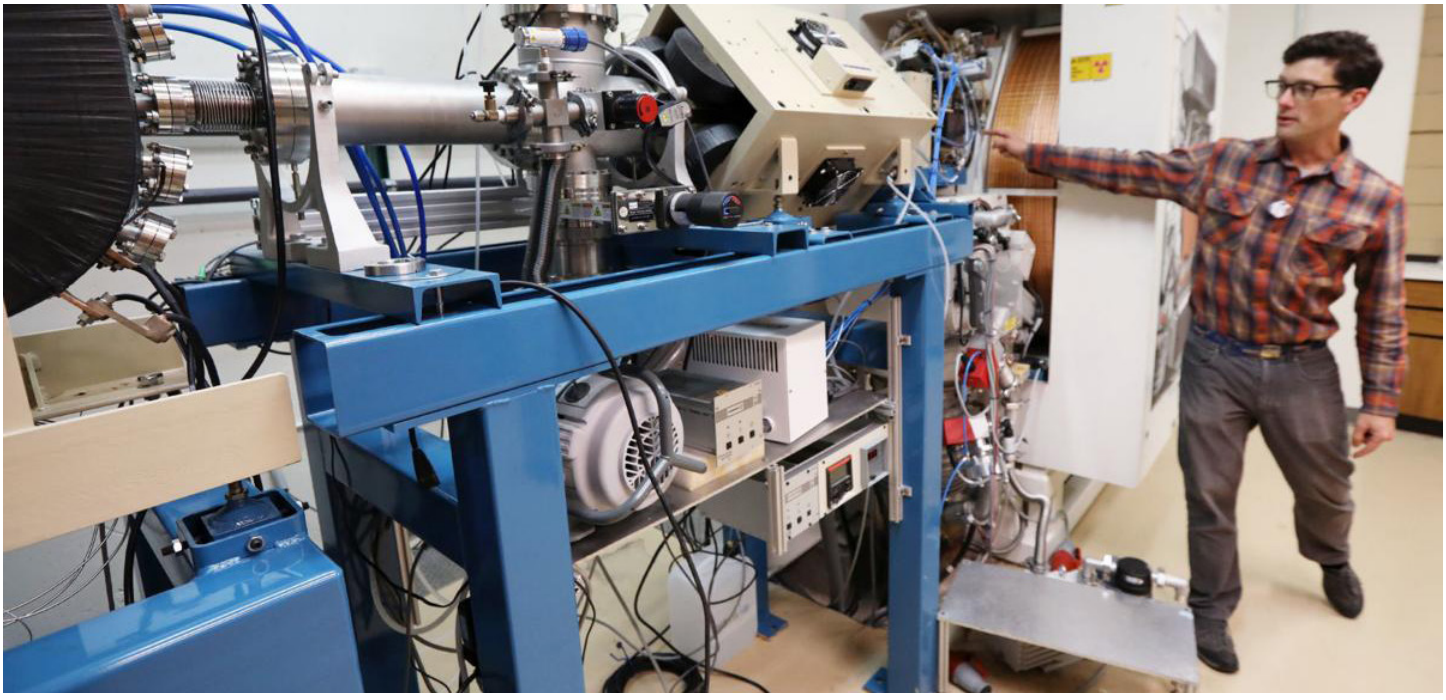
UW-Madison, which received a $19 million federal grant last year to continue the research, has given about 800 amyloid scans to about 450 people in the past decade. More than 350 people have received tau scans since the university started offering them two years ago. A dozen people have had synapse scans, which began last year.

The synapse scan study seeks to measure the decline in synapse density over time in people with and without Alzheimer's disease. The marker, distinct from the hallmark buildup of amyloid and tau, could offer a new clue to how the disease progresses.

Synapse density "might be an even earlier measurement of things going wrong in the brain," said Barb Bendlin, a neuroscientist leading the study. "Maybe someday there will be drugs that could protect the synapses."

Volunteering for scans

Sara Tirner has undergone 11 brain scans in dementia studies at the university, including one looking at her synapses.



The cyclotron in the basement of the Wisconsin Institutes of Medical Research near UW Hospital produces radioactive atoms for use in PET scans, said Jonathan Engle, Assistant Professor in the Department of Medical Physics, who works in the lab.

Her mother died from Alzheimer's two years ago at age 87, and her aunt has the disease. Their mother and grandmother also likely had it, as did Tirner's paternal grandmother.

"Who knows if I can avoid it," said Tirner, 58, of Madison. The family history, she said, "is pretty motivating."

After getting a finance degree at UW-Madison and working as a banker in Chicago, San Francisco and New York City, Tirner became a yoga instructor and returned to Madison.

In 2015, when her parents were no longer able to care for themselves, she moved in with them in Two Rivers, where she grew up. Her father died, at 94, from heart failure the following year; he also had vascular dementia.

By then, her mother's dementia was so advanced she didn't realize her husband was gone. She was diagnosed with dementia in 2012, but the first signs came years earlier, Tirner said.

Her mother, a real estate broker, Sunday school teacher and meticulous homemaker, stopped cleaning the house. When washing clothes, she started using too much detergent. One Christmas, she panicked because she forgot how to start making dinner.

Eventually, she could no longer dress or feed herself. Unlike some people with dementia who become agitated and aggressive, she was mostly docile and had a hard time talking.

"She couldn't find the words," Tirner said. "She was like an old computer that just keeps getting slower."

Tirner hopes the studies she's participating in yield findings that help her and others avoid dementia. With research suggesting exercise can delay or slow cognitive decline, she figures her yoga and other physical activity should help.

Unlike Tirner, Karen Ingmundson has no family history of Alzheimer's. But the retired state Capitol electrician has undergone a dozen brain scans in dementia studies at UW-Madison. She has friends whose parents have had the condition.

"I've seen what it's done to people," said Ingmundson, 66, of Waunakee. "It's a really devastating disease."

Amyloid theory questioned

No drugs have been approved for Alzheimer's disease since 2003, and the four medications available treat only symptoms.

Drug trials by Biogen, Eli Lilly, Johnson & Johnson, Merck and others have failed in recent years. In March, Biogen stopped two studies of aducanumab, an antibody to clear amyloid plaques in the brain, after partial results suggested it didn't work. In October, however, the company said it would apply for federal approval for the drug because further analysis showed a reduction in cognitive decline.

Pfizer, another pharmaceutical powerhouse, stopped Alzheimer's research altogether last year.

The lack of progress has spurred debate over the "amyloid hypothesis," the decades-old idea that amyloid causes Alzheimer's and removing it is the key to curing the disease.

"We're having a total rethink about this amyloid hypothesis," Dr. Scott Turner, director of Georgetown University's Memory Disorders Program, told journalists earlier this year at a National Press Foundation seminar on dementia issues.

Other factors — such as inflammation, hormones, oxidative stress or even infections like herpes — may contribute to dementia, Turner and other researchers say. Like HIV, which wasn't successfully treated until combination therapies became available in the mid-1990s, Alzheimer's might require several drugs to collectively target amyloid, tau and factors like inflammation, Turner said.

"It may take this combination before we really have a breakthrough," he said.

Federal funding for Alzheimer's disease research has ramped up, with $2.3 billion available this year, up from $631 million in 2015, said Dr. Marie Bernard, deputy director of the National Institute on Aging.

About 140 clinical trials looking at ways to prevent or treat dementia are underway, and more than 30 genes associated with Alzheimer's have been identified in recent years, Bernard said.

UW-Madison findings

Johnson, of UW-Madison, said the drug trial failures are discouraging but instructive. Most patients in the studies have long had amyloid plaques, which generally appear about a decade before tau tangles emerge, he said.

"It may be too late to stop the disease at that point," Johnson said. "The optimal time to deliver an amyloid-busting drug is before the tangles kick in."

Detecting precisely when people build up amyloid and tau, and deciding when to intervene with drugs, is a key goal of the university's expanding imaging studies, Johnson said.

"I haven't given up yet on the amyloid hypothesis," he said.

Already, by analyzing rates of change in amyloid scans, researchers have been able to estimate when individuals first developed amyloid, he said.

UW's WRAP study, in which nearly three-quarters of participants have a family history of Alzheimer's, continues to reveal other findings.

One involves a gene called APOE4. If a person has one copy of the gene, their risk for Alzheimer's disease triples. Two copies increases the risk about 10 times.

But having parents or other close relatives with Alzheimer's doesn't appear to contribute additional risk beyond APOE4 status, Johnson said.

The lack of a strong link to family history, separate from the gene, is surprising and may be reassuring to people whose parents develop Alzheimer's, he said.

Synapses and stool

The synapse study could help scientists figure out why some people with amyloid plaques and tau tangles don't develop dementia, Bendlin said.

An unidentified factor might protect their synapses, she said.

"Is there some other marker we need to look for, something that's making these people resilient to this building pathology?" Bendlin said.

UW-Madison is one of only two centers given federal funding for the synapse imaging research; the other is Yale University. That's largely because of the cyclotron located in the basement of the Wisconsin Institutes for Medical Research, which produces the radioactive atoms used in the PET scans.

The atoms used in the amyloid and synapse tracers have half-lives of 20 minutes, and the tau tracer half-life is about two hours, said Dr. Brad Christian, a medical physicist whose lab makes the tracers. The cyclotron's proximity to two PET scanners at the Waisman Center enables such research.

While most dementia research on campus focuses on the brain, a new study is also looking elsewhere: in feces.

In a study analyzing stool samples from 50 people, half of whom had Alzheimer's disease, Bendlin and other researchers found that those with the disease had fewer kinds of gut bacteria than healthy people. Also, some bacteria were more abundant, and others less abundant, in people with Alzheimer's.

The findings support the emerging idea of communication between gut microbes and the brain.

Now, the UW researchers are giving fecal transplants to 30 people, half with early Alzheimer's. The transplants are given orally in pills produced by OpenBiome, a stool bank in Cambridge, Massachusetts.

Enriching gut bacteria in people with dementia or at risk for the condition could prevent progression, Bendlin said.

"We don't expect that fecal microbiota transplant will be the miracle treatment for Alzheimer's disease," he said. "We're trying to see if we change the system in this way, what are the mechanisms and could those be targets for new drugs?"

Detecting precisely when people build up amyloid and tau, and deciding when to intervene with drugs, is a key goal of the university's expanding imaging studies.

Administrative Updates

The past year has been full of transitions and changes for the department's administrative team. The biggest change came with a change in leadership when **Edward Jackson, PhD** stepped down as Department Chair late last year. Department leadership and faculty are committed to continue what Jackson pioneered, including the Course Curriculum Transformation project, and have ensured the department stays at the forefront of research and education.

Recruitment of the next chair has been postponed due to the coronavirus outbreak; however, we anticipate that the next chair will be hired before the 2021-2022 academic year. **Timothy Hall, PhD** has been serving as Interim Chair and has agreed to continue doing so until a replacement is hired.

Amy Martens, MBA, was recruited by Vanderbilt University Medical School to serve as their Chief Business Officer. Martens' contributions as Department Administrator helped support innumerable changes within the department during her tenure at UW-Madison, and her helpful, can-do attitude is missed. In June 2020, **Kristina Weaver, MBA** joined the department to fill Martens' role. Prior to joining the Department of Medical Physics, Kristina served as the Research Administrator in the Department of Radiology at UW-Madison. She brings with her vast knowledge that will certainly help guide and lead the department for years to come.

Kymmy Lomax, Financial Specialist, also left the department for her promoted role in the SMPH Dean's Office as a Financial Specialist, Advanced. Kymmy was a crucial component of the administration team and she will be missed. However we are excited for her promotion into the Dean's Office. **Matthew Oestreich** was hired in March 2020 as a Financial Specialist to fill Lomax's role and has been a great addition to the department.

Two other administrative staff members were hired over the past year to fill vacant positions. **Allyson Hedding**, HR Business Partner and **Alyssa Mohr**, Assistant to the Chair, both joined the department in August 2019 and have been serving the department for almost a year. **Yacouba Traore, MS,** IT Manager, left the department in July 2020 after over 10 years with the department. He will be deeply missed throughout the department and wish him the best in his new endeavors.

New Faculty

We welcomed two new radiochemistry faculty who joined the department in May 2020.

Paul Ellison, PhD researches nuclear and radiochemistry to address challenges in nuclear medicine. Drawing from the fields of nuclear chemical elemental separations, small molecule synthetic radiochemistry, preclinical cancer models, and preparation of radiopharmaceuticals for human research, his work focuses on developing small molecules radiolabeled with matched positron-emitting and Auger-electron-emitting therapeutic radionuclides to plan and deliver targeted radionuclide therapy for cancers.

Reinier Hernandez, PhD '16, develops and implements novel radiotracers and radioanalytical techniques to answer biological questions about cancer and other diseases. One area he's focused on is generating, in close collaboration with the UW-Madison cyclotron group, radiolabeled compounds for positron emission tomography. He's also working on developing beta and alpha-emitting tumor-targeting compounds for targeted radionuclide therapy of cancer. He's particularly interested in employing targeted radionuclide therapy agents to modulate the immune microenvironment of tumors to potentiate immunotherapies' anti-tumor effects. He also seeks to create the next generation of tumor-selective Boron and Gadolinium compounds for neutron capture therapy.

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 send us your new address!

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How to Support the Department

The department's greatest need continues to be the ability to fill gaps in funding between extramural research support and university-supplied funds to support faculty, students, and staff in research, professional development, travel and to remain on the cutting edge of research and teaching.

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.

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