Summer 2021

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

The Medical Physicist

Inside This Issue

UW-Madison Medical Physics

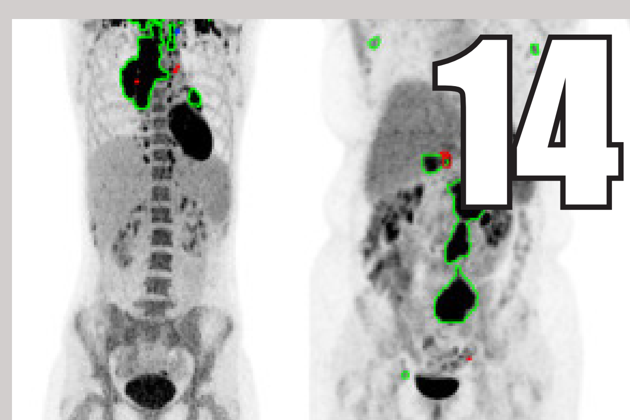
@wiscmedphys

Interim Department Chair: Timothy Hall, PhD
Department Administrator: Kristina Weaver, MBA

Newsletter Editor and Design: Alyssa Mohr

On the Cover

Students walking to class in spring 2021. The COVID-19 pandemic impacted the university in many ways. For more information on the department's response, see Page 8.



Greetings from the Chair

Professor Timothy Hall, 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. 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 year and a half as we navigated the many uncertainties from the coronavirus pandemic. It is with great pride and humbleness that I thank everyone for their fortitude during these unprecedented times.

Despite this past year looking different than our 'normal,' we made many great strides in our educational and research efforts. Thank you again to all researchers for your flexibility.

This year marks the 40th anniversary of the Department of Medical Physics as a stand-alone department on the UW campus. In celebration of this milestone, we highlight how the department was founded and continues to transform over time. In addition, each month we have showcased the multitude of individuals who've help shape the department over the last 40 years, and I urge you to read those enticing stories as well, which can be found on our website.

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. Over the course of the year, a group of alumni came together to initiate the creation of an endowment fund in honor of Emeritus Professor Paul DeLuca. 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 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 and inclusion, and look forward to continued learning opportunities and honest conversations through this next year that will continue to expand our understanding and allyship of our peers.

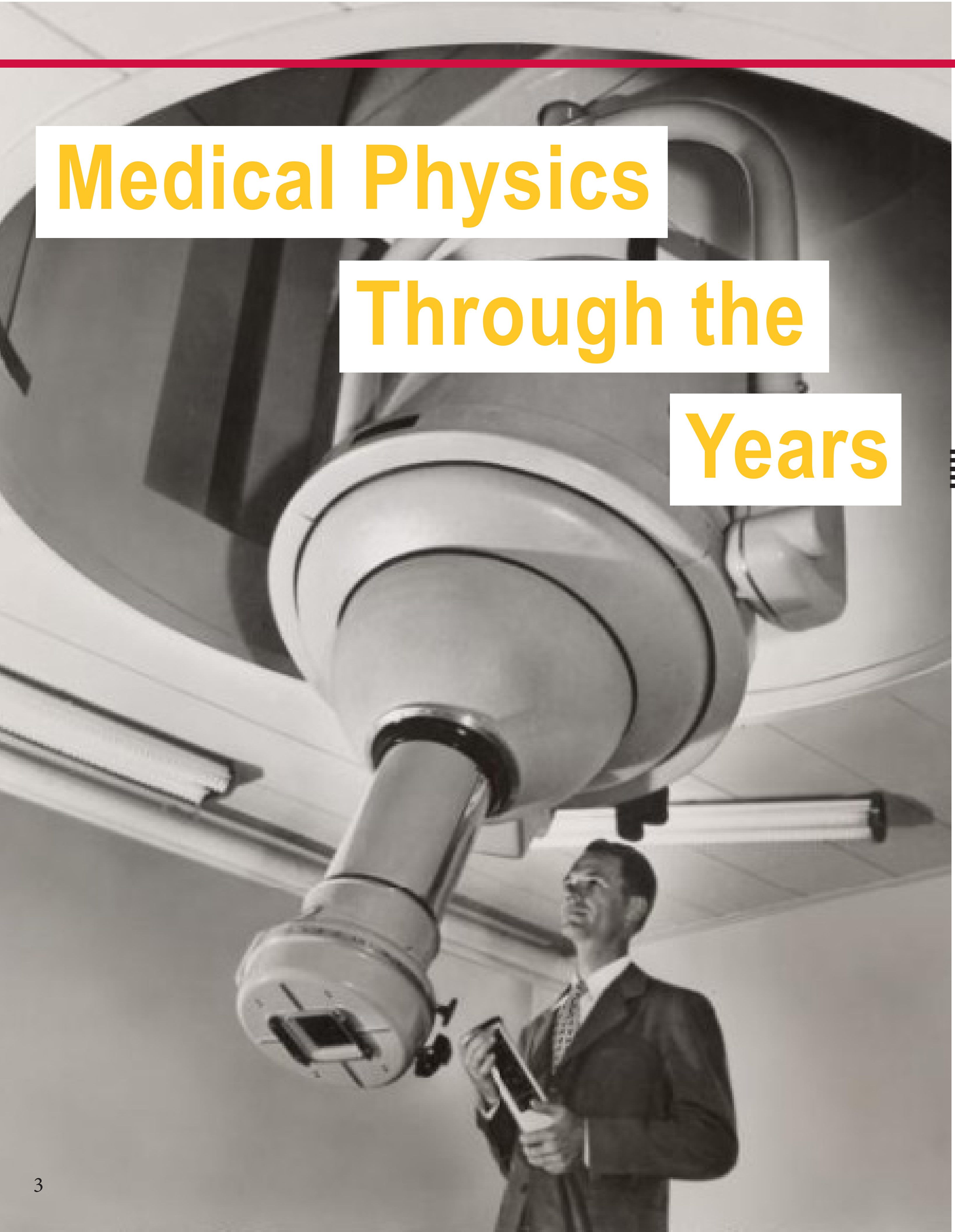
As always, we are eager to hear from our alumni and former faculty and staff. Please send any informational updates, such as changes of address, to Kristina Weaver, MBA (kmweaver@wisc.edu). If your travels bring you to or near Madison, please let us know, as we would be very pleased to see you and schedule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

As this issue of The Medical Physicist goes live, our campus is preparing for a full return of students for the upcoming fall semester. I look forward to our department reconnecting in-person once again in the near future!

It has been 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!

Medical Physics Through the Years



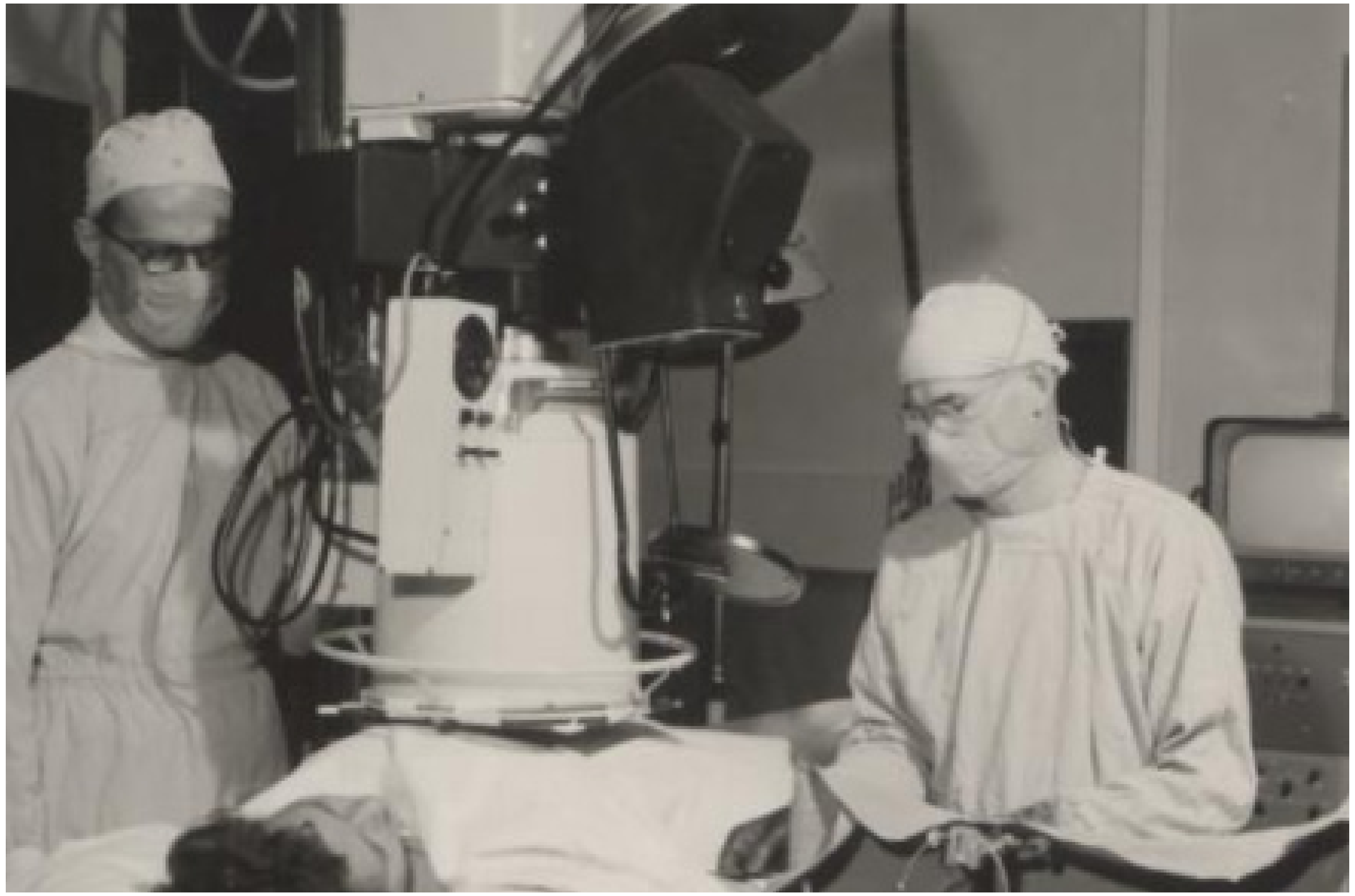
This year marks the 40th anniversary of the Department of Medical Physics. The medical physics program at the University of Wisconsin begain in 1958 when John R. Cameron accepted an appointment in the Department of Radiology with a joint appointment in the Department of Physics. Professor Cameron soon began attracting physics students to study and perform research in this new area of applied physics, and thus began a fertile association that would soon bring forth the Department of Medical Physics.

This process accelerated after he obtained a research grant from the Atomic Energy Commission to study thermoluminescent dosimeters. He also received research support from NASA for his work in measuring bone mineral in vivo. By 1966 he had guided students to the completion of eleven Master of Science degrees and one Doctor of Philosophy.
Professor Cameron also began to create positions for other faculty members, and by 1981 the Medical Physics Section of the Department of Radiology included seventeen faculty and collateral faculty in various medical physics subspecialties. At that time a new, free-standing Department of Medical Physics was created in the University of Wisconsin Medical School.

The first Ph.D. awarded in Medical Physics was to N. Suntharalingam in 1967, whose thesis was entitled, "Thermoluminescent Response of Lithium Fluoride to Radiations with Different LET."

From 1967 through today more than 300 students have earned their doctorates with thesis research in virtually every area of medical physics.

All through 2021, the department is highlighting the department's history through monthly newsletters that spotlight the becomings of the department.



1964; Doctors William C. Zarnstorff and George Rowe, in surgical dress, use a heart x-ray machine on a patient. (Curtesy: UW Library)

UW-Madison Medical Physics Degrees Awarded

Congratulations to the Medical Physics graduates of 2021! Graduates were invited to attend an in-person ceremony at Camp Randall Stadium, which included listening to a speech by keynote speaker and Honorary Degree Recipient psychologist John Gottman. The University of Wisconsin-Madison's spring commencement ceremony for 1,266 master's degree students and 871 doctoral candidates took place on May 8, 2021. Because of the ongoing coronavirus pandemic, in-person attendance was limited to graduates and faculty escorts.

Doctoral Degrees

Rashid Al Mukaddim
Advisor: Dr. Varghese

Austin Bazydlo
Advisor: Dr. Alexander

Lindsay Bodart
Advisor: Dr. Speidel

Cole Cook
Advisor: Dr. Meyerand

Peter Ferjancic
Advisor: Dr. Jeraj

John Hayes
Advisor: Dr. Chen

Ian Marsh
Advisor: Dr. Bednarz

Robert Pohlman
Advisor: Dr. Varghese

Alexandra Schroeder
Advisor: Dr. Eliceiri

Catherine Steffel
Advisors: Dr. Varghese and Dr. Mitchell

Ping Ni Wang
Advisor: Dr. Block

Yuxin "Annie" Zhang
Advisor: Dr. Hernando

Matthew Zammit
Advisor: Dr. Christian

Master's Degrees

Christina Breeze
Advisor: Dr. Varghese

Department Honors and Awards

Faculty

Andrew Alexander	Biological Sciences Divisional Committee Member
Walter Block	AIMBE Fellow, Class of 2021
Kevin Eliceiri	Fellow of the Optical Society of America AIMBE Fellow, Class of 2021
Marina Emborg	Kellet Mid-Career Award

Emeritus Faculty

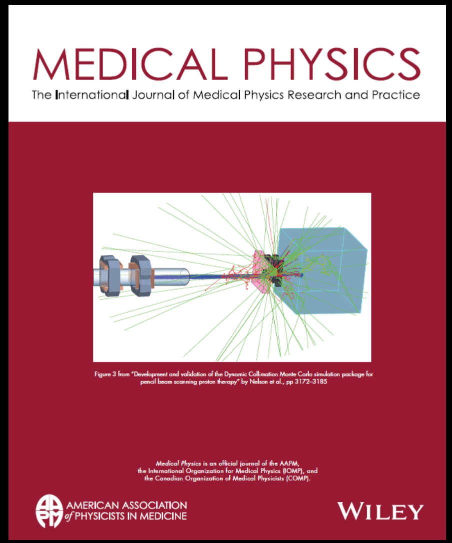
Charles Mistretta	Fellow of the National Academy of Inventors

Staff

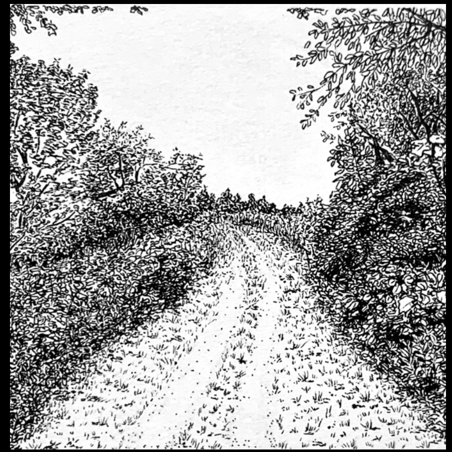
Leonardo Rivera-Rivera	Junior Fellow for the International Society for Magnetic Resonance in Medicine
Kristina Weaver	Artwork featured in Corpus Callosum
Ran Zhang	Sylvia & Moses Greenfield Award

Students

David Adam	Finalist for the John Cameron Early-Career Investigator Symposium at AAPM
Sydney Jupitz	Artwork featured in Corpus Callosum
Anthony Mancinelli	Undergraduate Parkinson's Foundation Summer Fellowship
Nick Nelson	Lead Author of *Medical Physics* cover artwork
Samuel Neuman	Undergraduate Hilldale Award
Kevin Treb	Finalist of Robert F. Wagner All Conference Best Student Paper Award
Heqiao Zhu	Undergraduate Hilldale Award



Nick Nelson cover art in Medical Physics



Sydney Jupitz artwork featured in Corpus Callosum

Vice Provost for Faculty and Staff Affairs Beth Meyerand, PhD appointed in summer 2020

As part of the Office of the Provost, the vice provost for faculty and staff works closely with individuals in administrative offices, deans of schools and colleges and other units across campus to address issues of concern to faculty and staff.

The vice provost for faculty and staff supports faculty and staff recruitment and retention through the Strategic Hiring Initiative and the Faculty Diversity Initiative, as well as through the administration of the proceeds of the Vilas Trust, which provides highly prestigious professorships and awards for our faculty.

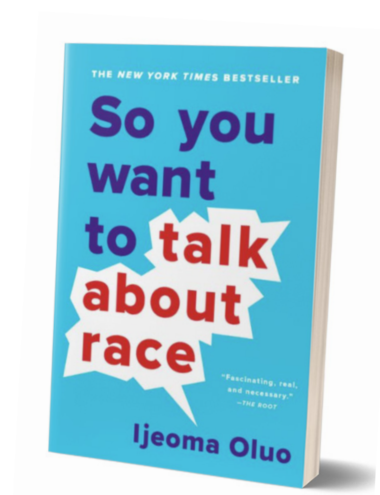
Recognizing Equity, Diversity and Inclusion in Medical Physics

The Committee for Recognizing Equity, Diversity, and Inclusion in Medical Physics (REDI), currently led by graduate students Jayse Weaver and Hayley Whitson, has continued to provide virtual events during the ongoing pandemic. Following a town hall in June of 2020 to discuss racism and equity in STEM, the first REDI Book Club was organized and ran throughout the fall of 2020 and into 2021. Students, faculty, and staff read "So You Want to Talk About Race" by Ijeoma Oluo with chapter discussions held every 3 weeks. The book club is set to continue in Fall 2021 after tremendous success. After a long pandemic-related delay, REDI was pleased to have Heather Whitney, PhD, give a seminar talk in March of 2021 and meet with faculty and students during a day-long virtual visit.

Following Dr. Beth Meyerand's promotion to Vice Provost for Faculty and Staff Affairs, REDI welcomed Walter Block, PhD, and Bryan Bednarz, PhD, as faculty sponsors of REDI in spring 2020. Throughout the last year, the co-chairs of REDI, faculty sponsors, and other members of the department have been participating in the American Physical Society's Inclusion, Diversity, and Equity Alliance (APS-IDEA), a network focusing on empowering physics departments, laboratories, and other organizations. Members attend diversity-related talks and workshops, as well as small community gatherings to exchange ideas, develop plans, and share victories.

REDI plans to host additional town halls throughout the next academic year to continue conversations on racism and equality in medical physics, specifically focused on educating and advocating for new policies that foster inclusion in STEM.

To contact REDI to discuss upcoming events, suggest seminar speakers, plan future events, or to just talk with us, please email redi@medphysics.wisc.edu.



Medical Physics During COVID-19 Times

This past year was surely one of the most unusual years in our university's history.

The university began the 2020-21 academic year by welcoming students back to campus, with many modifications in place to protect the health and safety of the campus community. The university offered a full curriculum, with many courses delivered in person until the Thanksgiving recess. After Thanksgiving, the university switched to a virtual format for all courses for the fall semester's final nine days of instruction plus exams.

In the spring semester, most classes remained virtual. Some classes with small class sizes continued in person, including many labs requiring hands-on learning. Some classes had a hybrid model with both virtual and in-person students.

In January, the department hosted its first fully virtual open house for admitted students to the Department of Medical Physics. All other department events remained virtual or were postponed throughout the academic year as well.

Unless research could be conducted remotely, directly benefited patient care or gained permission related to COVID-19, studies were temporarily halted in March 2020. Throughout the spring semester, research in the department has slowly ramped back up. We are hopeful that research will return to pre-pandemic times this fall.

In the spring 2021 semester, the university rolled out the Safer Badgers app to help track COVID-19 cases and ensure regular testing, and negative COVI-19 tests, among individuals that were coming onto campus. Beginning January 25, to enter a building on campus, individuals had to be in compliance with campus testing policy by having a green "building access granted" checkmark in their Safer Badgers app. At many campus buildings, trained employees called Badger Wellness Ambassadors asked to see your Badger Badge before you could proceed into the building.

There continues to be encouraging progress in the fight against COVID-19 both on campus and in the broader community. Cases in Dane County have dropped to their lowest level since May 2020, driven by exceptionally strong participation in vaccination. Of those eligible to be vaccinated in Dane County, 78.5% have received at least one dose.

Faculty, staff and students who have worked remotely over the last 18 months began returning to their on-site workplaces over the last few months. Chancellor Rebecca Blank announced this summer that the university plans to operate fully on-site this fall. In her statement, Blank shared that "we best fulfill our teaching, service and research missions when we work, learn and connect together in-person. On-campus interactions build connections between employees, facilitate quick exchange of information and help integrate new staff into office culture and operations."

Department leadership continues to be grateful to all of our staff, faculty and students for their extraordinary efforts over the past 18 months. We look forward to reuniting in-person in the coming weeks.

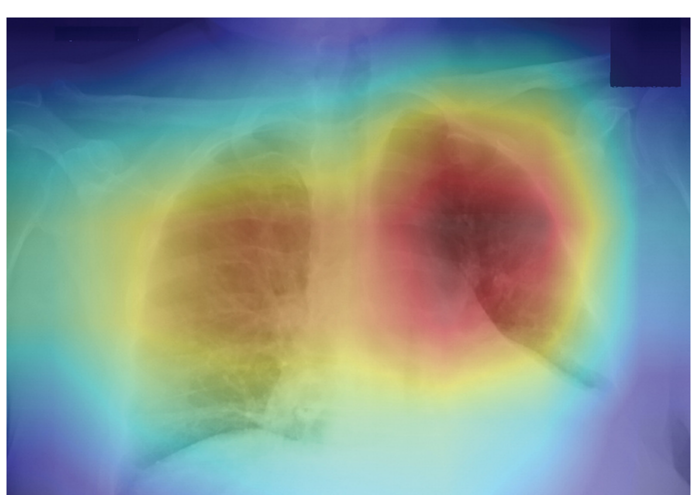
Fourteen sites across the UW campus offered free saliva-based diagnostic PCR COVID-19 testing. Regular testing was required for employees working on campus and students attending in-person classes or using campus space.

Department Student Representatives hosted a virtual 'happy hour' for admitted students during Open House 2021.

UW Researchers Find More Precise Way to Detect Pneumonia Caused by COVID-19

Using cutting-edge artificial intelligence technology, UW-Madison investigators have developed a far more precise way to identify cases of COVID-19 induced pneumonia.

By Emily Kumlien, UW Health



Using a custom artificial intelligence algorithm called CV19-Net, the UW research team dug into a vast resource database of tens of thousands of COVID-19 chest X-rays to show its method could identify pneumonia caused by COVID-19 at a sensitivity of 88%, according to Guang-Hong Chen, PhD, professor of medical physics and radiology at the University of Wisconsin School of Medicine and Public Health.

From the tens of thousands of X-rays available, the team pared down the number of X-ray images to train the artificial intelligence algorithm and then evaluated the performance of the CV19-Net algorithm over 5,900 X-rays from approximately 3,000 patients between Feb. 1 and May 3, 2020.

To compare to diagnoses generated by the human eye, Chen's team asked three expert thoracic radiologists experienced with COVID-19 pneumonia X-ray images to examine 500 chest X-ray images from the CV19-Net database. The three radiologists were able to correctly perform diagnosis with accuracy of 76%, 68% and 72%. In contrast, the CV19-Net algorithm examined the images and achieved a diagnostic accuracy of 84%.

"It is clear, based on the data; we conclude that artificial intelligence can identify COVID-19 pneumonia better than the human eye," Chen said.

Chen and the research team that includes Ran Zhang, PhD, assistant scientist in medical physics, and Scott Reeder, MD, PhD, professor of radiology and medical physics, both at the UW School of Medicine and Public Health, and other researchers and clinicians at both UW School of Medicine and Public Health and Henry Ford Health System in Detroit, Michigan. Reeder is also a UW Health radiologist.

The team is currently determining how to utilize this new technology to help health care workers in the field identify COVID-19 cases in just minutes using X-ray techniques rather than more costly and less available computerized tomography (CT) scans, Reeder said.

Such an algorithm could even be deployed into the X-ray machine itself so that the detection of COVID-19 pneumonia could be made before the images are transmitted to the radiologist's computer screen, he said.

"The algorithm could even page the radiologist to alert them to review the case in a real-time manner, so that a diagnosis and report can be made within just a few minutes," Reeder said. "Indeed, it would be a straightforward extension to even generate a preliminary report, before the radiologist has even reviewed the X-ray images."

Chen and his team are working with scientists at Epic, a Verona, Wisconsin, company that provides health record software to hospital systems, and UW Health to develop the clinical use of the algorithm. The algorithm would produce a COVID-19 risk score immediately after a chest X-ray image is taken, Chen said.

A next step would be to create a more universal algorithm for COVID-19 screening, he said, not just for COVID-19 cases with pneumonia findings, but also other COVID-19 cases, like people with with mild or no pneumonia findings.

"Once developed, this could become a fully automatic tool for COVID screening," Chen said. "Again, it just underscores the power and potential of artificial intelligence in medical practice."

The work received funding from the Wisconsin Partnership Program.

Research aids in understanding and diagnosing COVID-19

Ran Zhang, PhD, assistant scientist in the Department of Medical Physics, points to a section of the X-ray highlighted red by the team's artificial intelligence algorithm, indicating COVID-19 induced pneumonia.

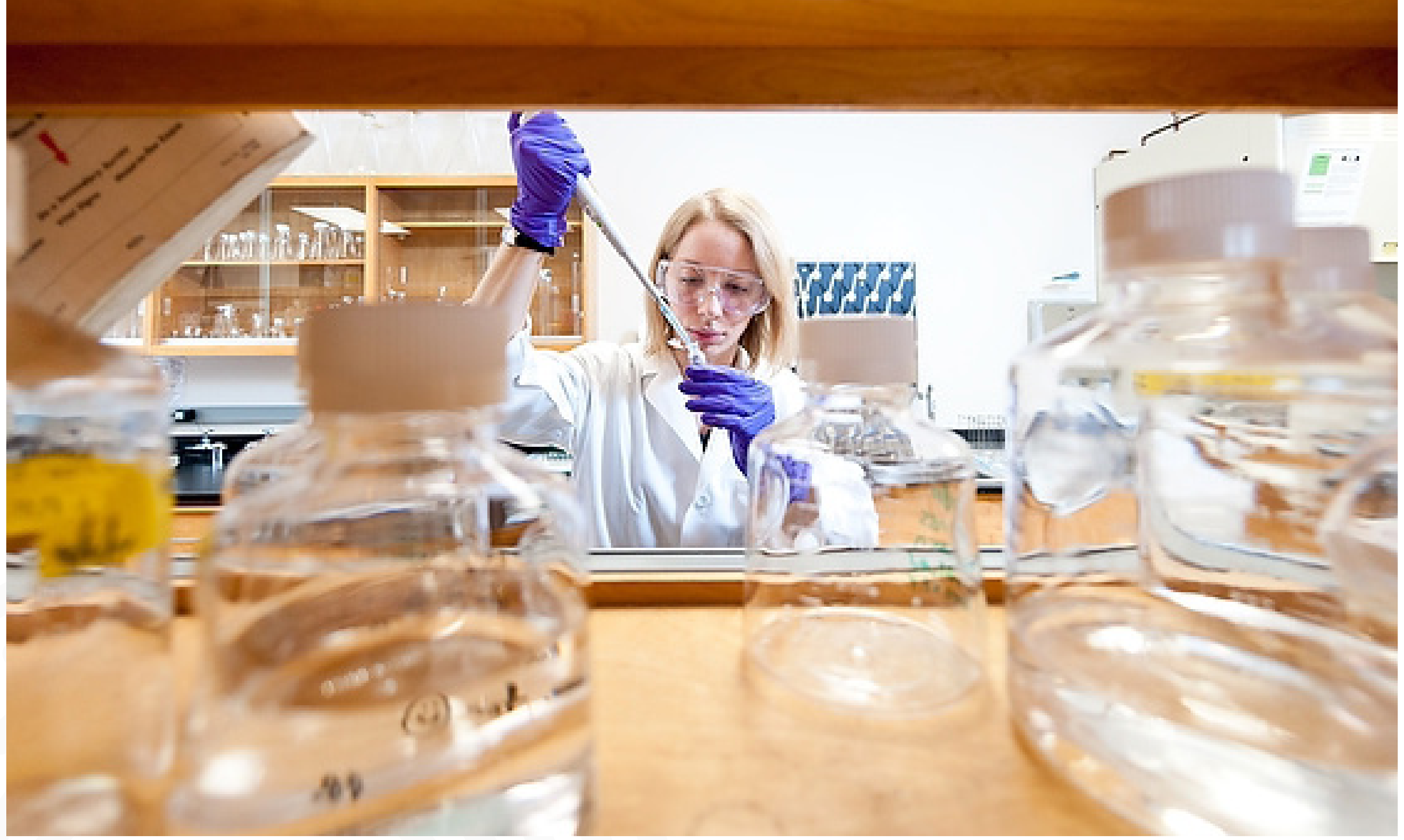
One of the school's most-read articles of the year details research published in April on how certain types of respiratory allergies, asthma, and controlled allergen exposure were associated with significantly reduced gene expression in a protein that the coronavirus uses to infect cells with COVID-19. This suggests a possible reason why people with a respiratory allergy and asthma unexpectedly did not seem to experience some of the more severe and life-threatening manifestations of the COVID-19 disease.

A breakthrough in October 2020 was aimed at speeding up diagnosis of COVID-19 induced pneumonia. School researchers devised a custom artificial intelligence algorithm that can identify cases of COVID-19 induced pneumonia based on automated analysis of chest radiographs (X-rays). This ability to screen patients quickly for COVID-19 infection can speed up diagnosis, allowing better patient outcomes.

UW Researchers Develop Treatment Alleviating Parkinson's Symptoms in Monkeys

A decades-long study shows brain cell grafts reversed motor and mood-related symptoms of Parkinson's disease in rhesus monkeys

By Rachael Lee, The Badger Herald



Parkinson's disease is a neurodegenerative disease which affects millions of people worldwide. According to the National Institute on Aging, the most prominent symptoms of this illness involve tremors and loss of mobility and balance. Parkinson's can, however, also affect the functioning of muscles in the digestive and cardiovascular system and is associated with the development of mood disorders, such as depression and anxiety.

Parkinson's disease occurs when dopamine-producing brain cells known as "dopaminergic neurons" die. An area of the brain called the substantia nigra produces a substantial amount of dopamine and is the structure which is primarily affected in Parkinson's disease. When connections from the substantia nigra to other parts of the brain, such as the striatum, degenerate, the result is the loss of dopamine in many important brain structures.

Medical Physics Professor at University of Wisconsin Dr. Marina Emborg said Parkinson's disease develops in the brain long before symptoms begin to manifest — more than 50% of the substantia nigra is lost before most patients develop early symptoms, such as tremors.

To combat the symptoms and slow the progression of the disease, patients are administered L-DOPA, which the body can use to produce more dopamine, or undergo other forms of dopamine replacement therapy to boost dopamine levels throughout the brain, Emborg said. There are limitations to L-DOPA, however. Increasing dopamine levels do not alleviate certain symptoms and complications caused by Parkinson's, such as heart problems and mood disorders, Emborg said.

This could be different. UW researchers developed a new treatment for Parkinson's disease which showed significant reversal of Parkinsonian symptoms in rhesus monkeys at the Wisconsin National Primate Research Center.

The study, published in the science journal "Nature Medicine," shows that when rhesus monkeys were implanted with dopaminergic neurons which were grown from their own cells, also known as an autologous transplant, symptoms of Parkinson's significantly improved. This discovery was part of a large, interdisciplinary effort between neurobiologists, engineers and physicists across campus.

Researchers worked meticulously through each step of the research process to address many minute details of the study and the surgical procedures.

"To practice the surgeries, we used gels — like a jello — to mimic a brain, so when we are practicing how to do the injections … [we] make sure we have the right amount of cells and … rate of infusion of the cell in the brain … we do all that work before we go to primates," Emborg said.

Emborg also met with physicists and engineers to determine how to optimize the catheter design and successfully deliver brain tissue to the correct locations. There was a multistep process in ensuring the animal subjects would be treated in a humane and ethical way. Researchers used a live MRI technique, developed by UW Biomedical Engineer Walter Block, to help visualize the brain during the procedure and to improve accuracy. "When you have Parkinson's, you lose dopaminergic neurons, dopaminergic innervation," Emborg said. "So what we did with the therapy was replace the dopaminergic neurons that were lost in the disease."

This was done using cell grafts — lines of cells which were grown in a lab then implanted in an organism.

The idea of using cell grafts to combat the effects of Parkinson's was first proposed in 1917, and the first treatment ideas centered around the use of fetal tissue to grow neurons and replace damaged cells, Emborg said. This approach fell short — in a double-blind controlled trial, fetal tissue did not prove to be effective in repairing damage. In addition, fetal tissue grafts caused dyskinesia, or abnormal movement, in 56% of its patients as a side effect, Emborg said. There are also ethical concerns with using and sourcing fetal tissue, as well as inconsistencies with cell quality.

UW Professor Su Chun Zhang and his lab group developed the next approach using embryonic stem cells. The neurons grown from embryonic stem cells, however, required a lot of immunosuppression, because the brains of the monkeys were rejecting the cells instead of incorporating them into the body.

Finally, induced pluripotent cells, or iPSCs, derived from the skin of the rhesus monkey, were grown to produce dopaminergic cells. Injecting genetic material into an undifferentiated, developing cell via a virus made sure the cell would develop into a dopaminergic brain cell.

The discovery of a substance called 1-methyl-4-phenyl-1,2,3,6-tetrahydropyridine, or MPTP, which causes Parkinson-like illness in both humans and nonhuman primates, was critical in developing a Parkinsonian disease model from which treatments can be developed and tested. When MPTP enters the body and passes the blood-brain barrier, it is metabolized and forms neurotoxin MPP+, which kills dopaminergic cells by inhibiting the mitochondria in the cell body.

In order to produce Parkinsonian symptoms in monkeys, researchers injected MPTP into the unilateral intracarotid artery — this was also to produce symptoms in just one side of the body and to minimize the suffering of the animals. The researchers then evaluated the monkeys using a clinical rating used to assess Parkinson's in people and gave them tasks which tested their mobility, such as grabbing their favorite treat with one hand. Out of the 10 rhesus monkeys chosen for this study, scientists injected five of them with dopaminergic cells which were grown from their own stem cells — an autologous transplant. The other five were injected with dopaminergic cells which were from other monkeys, which is an allogenic transplant. Their symptoms and behavior were then monitored for the next two years.

The difference between the autologous and allogenic transplant results were crucial. While monkeys with allogenic grafts did not see much improvement and sometimes worsened, monkeys who received the autologous transplants saw an average of 40% improvement of symptoms and significantly higher levels of dopamine in their brains within six months of surgery.

Emborg said the autologous implanted cells integrated into the body seamlessly. The body accepted them as their own and saw extended growth. Meanwhile, because the allogenic grafts were sourced from other monkeys, an immune response meant cell growth and innervation was limited.

"The reason that this [treatment] works so well is because the cells are autologous … that's the reason why the cells were able to integrate really well," Emborg said. "And that made a huge difference because they work much better in the brain."

An interesting additional effect of treatment was the improvement of mood in monkeys who received an autologous transplant. When monitored before and after treatment, monkeys with an autologous graft had dramatically reduced symptoms of depression (disinterest in tasks), anxiety (pacing around or agitated behavior) and self-injurious behavior. Monkeys with allogenic transplants saw no such improvements in mood.

The results of this study are promising for the future of Parkinson's disease treatment. The next steps would be to translate the results and procedures from rhesus monkeys to humans and further study whether this would be a safe, viable treatment.

"The next thing you need to do is work with the Food and Drug Administration … if we are going to go into clinical trials … usually they would like to see tolerability … so when you are thinking about clinical translation, you need to think, what can go wrong," Emborg said. "I need to test how many cells will be safe to inject, I need to test if the cells become tumorigenic … that's what we are looking for, that is the plan."

Deep-Learning Model Enables Rapid Lymphoma Detection in PET/CT Images

By Laura Patricia Kaplan, Physics World

The research group at the University of Wisconsin-Madison. From left to right: Timothy Perk, Alison Roth, Peter Ferjančič, Robert Jeraj, Daniel Huff, Brayden Schott, Ali Deatsch, Victor Santoro Fernandes, Amy Weisman, Vince Streif. (Courtesy: Amy Weisman)

Whole-body positron emission tomography combined with computed tomography (PET/CT) is a cornerstone in the management of lymphoma (cancer in the lymphatic system). PET/CT scans are used to diagnose disease and then to monitor how well patients respond to therapy. However, accurately classifying every single lymph node in a scan as healthy or cancerous is a complex and time-consuming process. Because of this, detailed quantitative treatment monitoring is often not feasible in clinical day-to-day practice.

Researchers at the University of Wisconsin-Madison have recently developed a deep-learning model that can perform this task automatically. This could free up valuable physician time and make quantitative PET/CT treatment monitoring possible for a larger number of patients.

To acquire PET/CT scans, patients are injected with a sugar molecule marked with radioactive fluorine-18 (18F-fluorodeoxyglucose). When the fluorine atom decays, it emits a positron that instantly annihilates with an electron in its immediate vicinity. This annihilation process emits two back-to-back photons, which the scanner detects and uses to infer the location of the radioactive decay.

Because tumours grow faster than most healthy tissue, they must consume more energy. Much of the radioactive tracer will therefore be drawn towards the lymphoma lesions, making them visible in the PET/CT scan. However, other types of tissue, such as certain fatty tissues, can "light up" the scans in a similar manner, which can lead to false positives.

Neural networks: accurate and fast

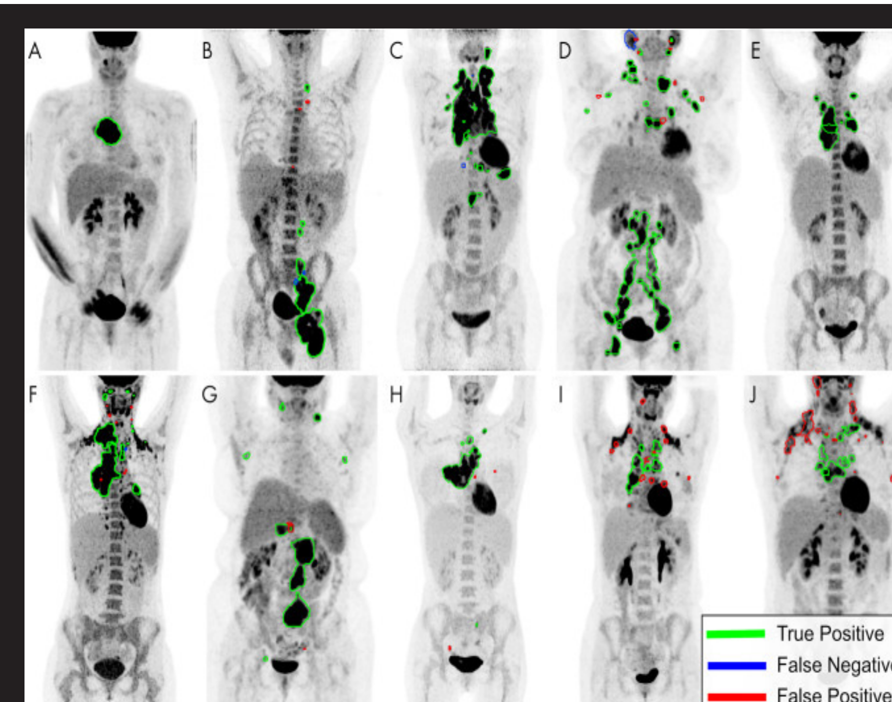
In their study, published in Radiology: Artificial Intelligence, Amy Weisman and colleagues investigated lesion-identifying deep-learning models built from different configurations of convolutional neural networks (CNNs). They trained, tested and validated these models using PET/CT scans of 90 patients with Hodgkin lymphoma or diffuse large B-cell lymphoma.

For this purpose, a single radiologist delineated lesions within each scan and classified each one on a scale from 1–5, depending on how sure they were that a lesion was malignant.

The researchers found that a model consisting of three CNNs performed best, identifying 85% of manually contoured lesions (923 of 1087, the so-called true positive rate). At the same time, it falsely identified four lesions per patient (the false positive rate). The time to evaluate a single scan was cut from 35 minutes using manual delineation to under two minutes for the model.

carefully delineated scans. The study authors tested how well their model performed depending upon the number of patients used for training. Interestingly, they found that a model trained on 40 patients performed just as well as one trained on 72.

According to Weisman, obtaining the detailed lesion delineations for training the models proved a more challenging task: "Physicians and radiologists don't need to carefully segment the tumours, and they don't need to label a lesion on a scale from 1 to 5 in their daily routine.



Ten different examples of ensemble convolutional neural network (CNN) output. Maximum intensity projections (MIPs) of PET images with overlaying MIPs of the 3CNN output show true-positive findings (green), false-positive findings (red), and false-negative findings (blue).

A-H show patients of varying disease burden and varying performance. I-J show patients with an above average number of false-positive findings who had significant 18F fluorodeoxyglucose uptake of brown fat in the neck, shoulders, and ribs.

It is extremely difficult to classify every lymph node in a scan as cancerous or not with 100% certainty. Because of this, if two radiologists delineate lesions for the same patient, they are not likely to agree with each other completely. When a second radiologist evaluated 20 of the scans, their true positive rate was 96%, while they marked on average 3.7 malignant nodes per patient that their colleague had not. In these 20 patients, the deep-learning model had a true positive rate of 90%, at 3.7 false positives per scan – making its predictions almost as good as the variation between two observers.

Expected, and unexpected, challenges

Often, one of the biggest hurdles in creating this type of model is that training it requires a large number of

So asking our physicians to sit down and make decisions like that was really awkward for them," she explains.

The initial awkwardness was quickly overcome, though, says Weisman. "Because of this, Minnie (one of our physicians) and I got really close during the time she was segmenting for us – and I could just text her and say 'What was going on with this image/lesion?'. Having a relationship like that was super helpful."

Future research will focus on incorporating additional, and more diverse, data. "Acquiring more data is always the next step for improving a model and making sure it won't fail once it's being used," says Weisman. At the same time, the group is working on finding the best way for clinicians to use and interact with the model in their daily work.

New Faculty Spotlight

Ivan Rosado-Mendez, PhD

We welcomed a new ultrasound faculty member, Assistant Professor Ivan Rosado-Mendez, PhD, who joined the department in February 2021.

What are the main projects or topics that you will focus your research on?

The Department has a long-standing tradition of developing novel quantitative techniques for ultrasound imaging to measure acoustic properties of tissues. As a new faculty, my main interest is on advancing some of these quantitative ultrasound methods to reduce their bias and increase their precision, as well as to work towards their standardized clinical use as biomarkers for different physiological and disease processes. Moreover, I want to expand this research line by incorporating biomarkers of tissue function, particularly related to changes in the tissue blood supply by using high-resolution microvessel imaging and contrast-enhanced ultrasound.

There are various areas in which I would like to apply these ideas. As co-chair of the Pulse-Echo Quantitative Ultrasound (PEQUS) biomarker committee hosted jointly by the American Institute of Ultrasound in Medicine and RSNA/QIBA, I am working on the standardization of current commercial implementations of quantitative ultrasound biomarkers for the assessment of fat infiltration in the liver. At UW-Madison, I hope to collaborate with colleagues from the Department of Radiology to implement the recommended protocols that we develop as part of this effort. Furthermore, I would like to partner with radiologists and pediatricians to investigate the use of quantitative ultrasound methods for the diagnosis and surveillance of pediatric non-alcoholic fatty liver disease, as well as with colleagues from the UW Carbone Cancer Center to explore their use as predictive and prognostic biomarkers for breast cancer.

In the realm of functional ultrasound, I will investigate one of the physiological processes related to cervical remodeling during pregnancy that remains poorly understood: the changes in its vascular network. To this end I will implement a novel ultrasound based vascular imaging technique called Ultrasound Microvessel Imaging (UMI), which takes advantage of advanced high-frame rate imaging and signal processing techniques to improve the spatial resolution over conventional Doppler ultrasound. The goal of the initial project in this area will be to demonstrate the feasibility of in vivo imaging of the changes in cervical vascularity during pregnancy in a small animal model (rat) using both contrast- and contrast-free UMI.

What's one thing you hope students who take a class with you will come away with?

From my perspective, one of the most valuable lessons I learned from my medical physics training at the National Autonomous University of Mexico and at UW-Madison was the importance of having a sound knowledge and understanding about the physics of the imaging modality or therapy approach we are using or are interested in. It is only through them that we are able to extrapolate the knowledge to create novel solutions to clinical needs and to adapt the way we communicate to transmit the understanding to colleagues within health care teams. This is one of the key take-away messages that I'd like students to get from my class.

What is your favorite thing about being a medical physicist?

One of my favorite things about being a medical physics is that we are constantly challenged to learn and to be creative. By being at the crossroads of two complex disciplines, physics and medicine, we are always moved to learn and create new ways in which physics can be used to solve clinical needs. Since clinical needs are basically endless, our creativity, curiosity and ability to self-learn and explore new ideas are constantly put to work.

What other hobbies do you have?

I enjoy going for a run or bike rides with family and friends and spending time with our dogs. I also enjoy reading fiction and political opinion with a good cup of tea and some classical music (particularly fond of Erik Satie and Claude Debussy).

We've missed you! Department alumni, faculty, students, and friends are invited to attend the UW-Madison Department of Medical Physics Virtual Reception. The reception will kick off with remarks from department leadership at 6:00PM (EDT) following AAPM sessions.

We will be using the online platform, Remo. 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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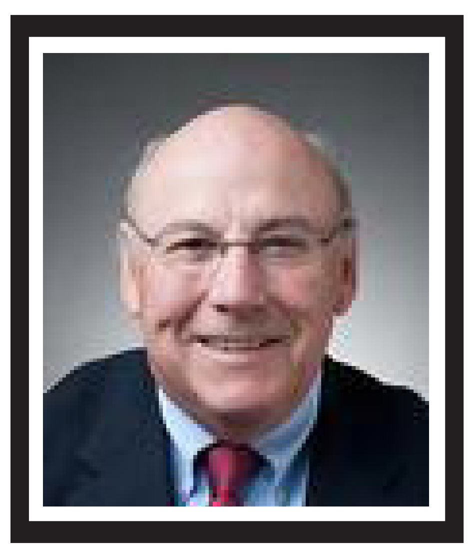
MAKE YOUR LASTING GIFT TODAY

Make your donation to the Paul DeLuca, PhD Scholar Fund

Shy of a nearly 50 year career on the UW-Madison campus, Paul M. DeLuca Jr., Emeritus Professor of the Department of Medical Physics, retired as provost and vice chancellor for academic affairs in 2014. DeLuca left a lasting legacy at the university that will be felt by generations to come.

Paul arrived at UW as a postdoc in 1971, shortly after receiving his doctorate in nuclear physics from the University of Notre Dame. In 1973, he became an assistant scientist in the Medical Physics Section of the Department of Radiology. He joined the faculty as an adjunct professor in 1974 and was named a full professor in 1985 in what we all know is the Department of Medical Physics, where he subsequently led for more than 10 years as chair. Professor DeLuca was Associate Dean for Research and Graduate Studies in the Medical School from 1999—2009 when he was appointed Provost by then-UW-Madison Chancellor Biddy Martin.



Paul M. DeLuca Jr., PhD

At UW-Madison, the provost serves as the lead academic official, helping to set and guide the university's academic missions of research and education. The provost works closely with the chancellor and with the deans of UW-Madison's 13 schools and colleges, and oversees programs for faculty and staff, diversity initiatives and enrollment management. The position also serves as the point official for shared governance. In the absence of the chancellor, the provost assumes the role of chief executive.

During his tenure as provost, Paul oversaw a major leadership overhaul for the university - perhaps the largest in the institution's history - playing a lead role in the recruiting and hiring of 10 new deans and directors for various schools, colleges and institutes. The Madison Initiative for Undergraduates (MIU), an effort to enhance and improve the quality of the undergraduate experience, also blossomed under Paul's watch with the hiring of a cadre of new faculty and staff in critical mission-driven areas.

Paul's years of work as an administrator helped shape UW's future. As vice dean of the School of Medicine and Public Health, a position he held just before becoming provost, Professor DeLuca was deeply involved in the development of the Wisconsin Institutes for Medical Research (WIMR), a burgeoning biomedical research complex on the west campus, and where the Department of Medical Physics is currently located. Paul helped form both the physical and intellectual underpinnings of WIMR, which seeks an innovative approach to treating human disease through synergistic interdisciplinary collaboration.

As a scholar, Paul is known for his studies on the effects of high-energy particle radiation on humans. He is the author or co-author of more than 75 research papers, many focusing on the various applications of physics to the diagnosis and treatment of cancer. In addition, he has numerous technical reports, book chapters and other publications to his credit. As a teacher, he has supervised nearly 50 graduate students and postdoctoral fellows through graduate work or postdoctoral training. Paul's influence in the department is still felt just as much today as it was when he joined the department nearly 40 years ago, and has left lastly impressions on students and colleagues around the globe.

In fall of 2020, former students of Paul began the formation of an endowed fund in his name. While all gifts are welcome and appreciated, the new Paul DeLuca Endowment Fund will allow donors to have a lasting impact on the Department of Medical Physics. These gifts will directly benefit students and create a legacy that will support Wisconsin Medical Physics now and in perpetuity. 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.

The department sincerely thanks all of the generous supporters who want to contribute to this endowed fund.

Other Ways to Give

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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Online Giving: www.medphysics.wisc.edu/about-us/donate/