SPRING 2025 BIOMEDICAL ENGINEERING

Pioneering Advancements in Prostate Cancer

Investigators at the Center for Imaging Research aim to transform diagnostics and therapeutics.

FULL STORY, p. 10

CASE WESTERN RESERVE UNIVERSITY | *Biomedical Engineering Alliance* | Cleveland Clinic

SPRING 2025

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The Biomedical Engineering Alliance
at Case Western Reserve University and Cleveland Clinic

IN THE NEWS

U.S. News & World Report

Case Western Reserve University tied for 19th in Biomedical Engineering

BEST UNIVERSITIES EduRank 2024

Best Universities for Biomedical Engineering in the World

#11 in North America

#10 in the United States

newswise

Researchers Harness AI to Predict Cardiovascular Risk From CT Scans

Newswise — CLEVELAND— Researchers at Case Western Reserve University, University Hospitals and Houston Methodist will harness the power of artificial intelligence (AI) to more accurately predict risk of heart failure and other cardiovascular events, including estimating when an adverse event might occur, by developing an AI model that "learns" from patient scans.

FROM THE CHAIRS

When new students and faculty members first arrive at Case Western University's Biomedical Engineering Department or Cleveland Clinic's Lerner Research Institute, they often cite two reasons that drew them to the institutions – the close proximity between the university and healthcare system and the opportunity to collaborate with leading multidisciplinary experts. That's the case for four faculty members, highlighted in this spring's newsletter, who joined the Biomedical Engineering Department at the start of the 2024-2025 academic year.

Rui Cao, Hamid Charkhkar, Ana Hernandez Reynoso and Luke Osborn are expanding the department's expertise in artificial intelligence, biomedical imaging and neural engineering and rehabilitation. You can read about their research projects in the article on page 6, as well as their partnerships with peers from the Lerner Research Institute and clinicians from area hospitals.

Collaboration is also central to the work of the Case Western Reserve University Center for Imaging Research (CCIR), which celebrates its 20th anniversary this year. Multidisciplinary investigators at the CCIR are at the forefront of biomedical imaging innovations that solve clinical problems for a multitude of diseases and conditions. We present four projects focused on prostate cancer beginning on page 10.

We also pay tribute to Dominique Durand, a professor in the Case Western Reserve University Department of Biomedical Engineering, Department of Neurosciences and Department of Physiology and Biophysics. Durand has dedicated his 42-year career at the university to solving problems in the nervous system. The profile on page 14 delves into his work as director of the Neural Engineering Center in the Case School of Engineering School of Medicine and his commitment to teaching undergraduate and graduate students.

That commitment to teaching – to disseminating information on biomedical engineering advancements and innovations – is evident in campus events hosted by university faculty, centers and affiliated consortiums. In this issue, we share details and photos from two symposiums: Five Decades of Restoring Upper Extremity Movement with Neuroprostheses: 1972 – 2024, presented by the Cleveland FES Center, and the 2024 Society for Biomaterials (SFB) Midwest Symposium, hosted by Case Western Reserve University.

We encourage you to read about these events, plus news about our faculty and students. And we invite you to engage with our faculty and reach out to us with your news at bme-news@case.edu.

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Allen H. and Constance T. Ford Professor and Chair of Biomedical Engineering

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The Virginia Lois Kennedy Endowed Chair in Biomedical Engineering and Applied Therapeutics

Lerner Research Institute
Cleveland Clinic

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STUDENT SPOTLIGHT

Dorian Durig

Doctoral Candidate Presents at International Conference

Dorian Durig, a doctoral candidate in biomedical engineering at Case Western Reserve University, presented a poster and an oral presentation at the 23rd annual International Symposium on Therapeutic Ultrasound in Taipei, Taiwan, last fall. Both presentations provided details on a study to investigate the kinetics and biodistribution of CAR-T cells labeled with nanobubbles, tracked by nonlinear contrast-enhanced ultrasound, in mice. Durig's poster was selected as a Student Poster Award Finalist at the conference, which is hosted by the International Society for Therapeutic Ultrasound. Durig is mentored by Agata Exner, a professor in the Department of Biomedical Engineering, Henry Willson Payne Professor in the Department of Radiology, Vice Chair of Basic Research in the School of Medicine and director of the CWRU Center for Imaging Research; and David Wald, MD, a professor in the Department of Pathology.

3MT® THREE MINUTE THESIS
FOUNDED BY THE UNIVERSITY OF QUEENSLAND

BME Grad Students Earn Top Spots in Three Minute Thesis Competition

Noa Nuzov, a graduate student in biomedical engineering at Case Western Reserve University, won the Three Minute Thesis (3MT™) competition at Case Western Reserve University in February for her presentation, "Mapping the Vagus Nerve to Improve Stimulation. Another graduate student in the department, Lauren Switala, placed second for her presentation, "The Road to the Heart for Gene Therapy." Developed by the University of Queensland and now held at over 900 institutions in more than 80 countries, 3MT celebrates the exciting research conducted by graduate students around the world.

Noa Nuzov

Lauren Switala

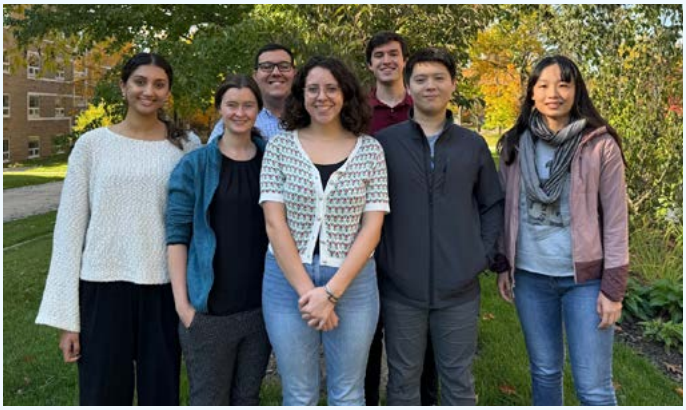
PhD Candidate Receives NDSEG Fellowship

Madelaine Blincoe, a doctoral candidate in biomedical engineering at Case Western Reserve University, was awarded the National Defense Science and Engineering Graduate (NDSEG) Fellowship from the U.S. Department of Defense. Blincoe works in the Advanced Platform Technology (APT) Center's Motion Study Lab with individuals with lower limb paralysis under the mentorship of Ron Triolo, executive director of the APT Center and professor of biomedical engineering at Case Western Reserve University.

Madelaine Blincoe

CCIR Launches the Imaging Research Trainee Council

The Case Western Reserve University Center for Imaging Research (CCIR) established the Imaging Research Trainee Council (IRTC) to encourage the engagement and career advancement of graduate students, postdoctoral researchers and research fellows throughout the imaging research community. The council is led by a group of trainees with guidance from faculty and staff. The IRTC will develop several events, including roundtable lunches with faculty, research presentations, off-campus tours of local imaging-related companies, panel discussions, networking opportunities, social activities and more.



See upcoming IRTC events at sites.google.com/case.edu/ccirtraineecouncil

Graduate Research Fellowship Program (GRFP)

The National Science Foundation awards more than 2,000 grants annually to help ensure the quality, vitality and strength of the scientific and engineering workforce. This year, the NSF recognized the following graduate students in biomedical engineering from Case Western Reserve University.

2025 Offered Award

Madison Albert

2025 Honorable Mentions

Nicholas Nazak

Niveda Kasthuri

Diarmuid Hutchinson

Madelaine Blincoe

FACULTY & STAFF HIGHLIGHTS

Jay L. Alberts

Jay L. Alberts, staff, Lerner Research Institute, Department of Biomedical Engineering, was featured in a March article entitled, "How Augmented Reality is Advancing Brain and Mental Health Treatment" in *The Scientist*, a quarterly magazine for life science professionals. Alberts shared his team's development of a digital avatar within an augmented reality platform, as well as a virtual reality assessment, to help clinicians provide simultaneous cognitive and motor task therapy to patients with neurodegenerative diseases, such as Parkinson's disease.

Jeff Capadona

Jeff Capadona, Vice Provost for Innovation at Case Western Reserve University and a professor in the Department of Biomedical Engineering, published an article in *Nature Communications* in February entitled, "Bacteria invade the brain following intracortical microelectrode implantation, inducing gut-brain axis disruption and contributing to reduced microelectrode performance." The article examines the effects of antibiotic use on the recording performance of implanted brain-machine interface intracortical microelectrodes and on overall blood-brain barrier health post implantation. The work was funded by the APT Center Steven Garverick Innovation Incentive Program, which supports pilot studies that nurture new ideas and concepts that are not yet grant eligible.

Mark Griswold

Mark Griswold and Chaitra Badve represented one of five research teams selected for a Collaborative Science Pilot Award supported by Case Western Reserve School of Medicine and University Hospitals (UH). Griswold is a professor in the Department of Biomedical Engineering at Case Western Reserve University and the Pavey Family Designated Professor of Innovative Imaging – Revolutionizing the Worlds of Education at the School of Medicine, and Badve is an associate professor of radiology in the School of Medicine and radiology physician and director of MRI at UH.

Griswold and Badve received the award, which is designed to encourage and advance team science between clinical and basic science faculty, for their work to organize and curate a magnetic resonance fingerprinting (MRF) database for hypothesis-driven sub-projects in various neurological diseases. The team also plans to leverage its infrastructure and expertise toward a larger vision of a multi-institutional MRF consortium to accelerate development of generalizable, validated biomarkers in neurological disorders.

Juhwan Lee

Juhwan Lee, a research assistant professor in the Department of Biomedical Engineering at Case Western Reserve University, obtained a 5-year, K01 award in medical imaging from the National Heart, Lung, and Blood Institute. Lee will develop methods for the non-invasive, quantitative evaluation of coronary artery disease in computed tomography angiography images. "This research could lead to improved detection of coronary artery disease and evaluation of its severity, paving the way for personalized treatments," says David Wilson, the Robert Herbold Professor of Biomedical Engineering and Radiology at Case Western Reserve University and Lee's primary mentor.

Shuo Li

Shuo Li was appointed to the Leonard Case Jr. Professorship in Engineering at Case Western Reserve University. Li, who joined the Department of Biomedical Engineering in 2021 as an associate professor, is a global leader in conducting multi-disciplinary research to enable artificial intelligence in clinical imaging-centered healthcare. "I am grateful for the support from my colleagues, mentors and the leadership at CWRU, especially Dean [of the Case School of Engineering] Ragu Balakrishnan for the nomination and Provost Joy Ward for the appointment," said Li in a post on X.

Paul Marasco

Paul Marasco, associate staff, Lerner Research Institute, Department of Biomedical Engineering, received a $1.4 million grant from the Department of Defense, Congressionally Directed Medical Research Program (CDMRP) Peer Reviewed Orthopaedic Research Program (PRORP) for his research on intuitive ultrasound-based upper limb prosthetic control and feedback utilizing targeted reinnervation for neuroma pain. Marasco also published an article in January in *Science* entitled, "Navigating the complexity of touch." The article presents findings of a study showing that precise cortical microstimulation improves tactile experience in brain-machine interfaces, which could improve applications for more precise bionic hands.

Kunio Nakamura

Kunio Nakamura, research scientist, Lerner Research Institute, Department of Biomedical Engineering, published an article entitled, "Subject-based transfer learning in longitudinal multiple sclerosis lesion segmentation" in the *Journal of Neuroimaging* in February. The article discusses results of a study that proposes two new transfer learning-based pipelines to improve segmentation performance for subjects in longitudinal MS datasets.

Anirban Sen Gupta

The Air Force Research Laboratory awarded a $1.8 million collaborative grant to the laboratories of Anirban Sen Gupta, the Wallace R. Persons Endowed Professor of Engineering and professor of biomedical engineering at Case Western Reserve University, and Michael Goodman, MD, a professor in the School of Medicine at the University of Cincinnati. The award supports work by the two laboratories to develop novel nanotherapeutics for traumatic brain injury.

In addition, Sen Gupta was a speaker at the 2024 International Symposium on Blood Substitutes, where he co-chaired the Platelets and Hemostasis track. Dante Disharoon and Sonali Rohiwal, senior research associates in the Sen Gupta Lab, also presented at the conference.

CWRU Hosts Biomaterials Symposium

Case Western Reserve University hosted the 2024 Society for Biomaterials (SFB) Midwest Symposium last fall at the Tinkham Veale University Center. More than 140 faculty members and students from SFB chapters throughout the Midwest attended the event, which featured presentations and posters on topics including tissue engineering, nanomaterials, bio interfaces, drug delivery, cardiovascular biomaterials, engineering cells and their microenvironments, and more.

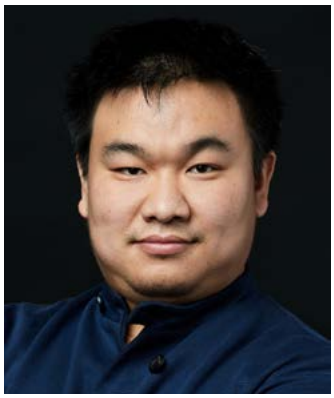
Shana Kelley, the Neena B. Schwartz Professor of Chemistry and Biomedical Engineering at Northwestern University, delivered the keynote address. Her research group has pioneered new methods for tracking molecular and cellular analytes with unprecedented sensitivity. Since 2023, Kelley has also served as president of the Chan Zuckerberg Biohub Chicago, a nonprofit organization developing technologies to understand inflammation and the immune system.

The SFB Midwest Symposium was organized by a program committee chaired by Anirban Sen Gupta, the Wallace R. Persons Endowed Professor of Engineering and professor of biomedical engineering at Case Western Reserve University, and Steven Eppell, associate professor of biomedical engineering at the university. In addition to speakers from Case and Northwestern, other represented universities included Arizona State University, Carnegie Mellon University, Duke University, the Massachusetts Institute of Technology, The Ohio State University, Rice University, the University of Cincinnati, the University of Michigan, the University of Kentucky, the University of Oregon and the University of Pittsburgh.

BME Welcomes Four New Faculty

The following faculty members joined Case Western Reserve University's Department of Biomedical Engineering at the start of the 2024-25 academic year, expanding the department's expertise in artificial intelligence, biomedical imaging and neural engineering and rehabilitation.

Rui Cao



> Ultimately, I hope our work will translate into practical clinical tools that enhance patient care, while also mentoring the next generation of biomedical engineers to drive further innovations in the field."
>
> **Rui Cao**

Rui Cao was named an assistant professor in the Biomedical Engineering Department at the School of Medicine in September 2024. "The opportunity to work in an environment that bridges cutting-edge research with direct clinical application is a major draw for those of us who are developing biomedical imaging devices," he says. "Additionally, the collaborative atmosphere and the institution's commitment to advancing healthcare through innovation aligned perfectly with my professional goals."

The Cao Lab at CWRU is primarily focused on advancing photoacoustic and ultrasound imaging technologies. The team develops novel hardware devices and sophisticated algorithms to push the limits of imaging resolution and sensitivity. Its research spans a variety of applications, including pathology, tumor and brain imaging, hemodynamics and oxygen metabolism.

"By combining hardware innovations with computational techniques, our goal is to enhance early disease detection and diagnostic accuracy," says Cao.

One of Cao's notable projects, funded by a K99/R00 Pathway to Independence Award from the National Institutes of Health, entails developing deep learning-assisted photoacoustic histology for real-time interoperative pathological diagnosis.

"The approach leverages artificial intelligence and label-free photoacoustic imaging to provide immediate, accurate diagnostic feedback during surgical procedures," says Cao. A December 2024 article in the journal Science Advances details the latest findings.

"Ultimately, I hope our work will translate into practical clinical tools that enhance patient care, while also mentoring the next generation of biomedical engineers to drive further innovations in the field," he says.

Hamid Charkhkar

Hamid Charkhkar was a post-doctoral scholar and senior research associate in the Biomedical Engineering Department before being appointed an assistant professor in July 2024.

“Case has very talented undergraduate students,” says Charkhkar. “When the opportunity presented itself to become a member of the faculty, I wanted to expand my collaborations and become more involved with the student body.”

> Overall, my goal is to look more holistically at developing technology that can help people with mobility issues."
>
> **Hamid Charkhar**

Charkhkar’s research aims to restore sensorimotor function to people with lower limb loss or neuromusculoskeletal impairment. His team developed a prosthesis that directly connects to the nervous system and re-establishes a link that was there prior to the amputation.

“When people lose a limb, the remaining highways – the nerves – are still there,” he says. “If you can develop a tool to put information in those highways and connect the flow of information with a robotic prosthesis, you can achieve a more natural and intuitive prosthesis/human interaction.”

Charkhkar’s team uses a closed-loop feedback system with their sensory neuroprosthesis to explore the effects of foot sensory feedback on balance, locomotion and activities of daily living. Last year, he received a $1.5 million grant from the U.S. Department of Defense (DOD) to study effects of the neuroprosthesis when it’s used at home and in the community during daily activities rather than in a lab setting.

Collaboration is key to Charkhkar’s research. Co-investigators on the DOD grant include colleagues in Case’s Department of Biomedical Engineering and clinicians from the Louis Stokes Cleveland Veterans Affairs Medical Center.

“I truly appreciate the level of interdisciplinary work that goes on at Case, especially with all the hospitals right around the campus,” says Charkhkar. “Every day I interact with clinicians and prosthesis users. It’s a level of engagement that you don’t normally see at other universities.”

In addition to his role at Case, Charkhkar holds two positions at the Louis Stokes Cleveland VA Medical Center. He is Director of Limb Loss and Prosthetics Research and an investigator at the Advanced Platform Technology Center.

“Overall, my goal is to look more holistically at developing technology that can help people with mobility issues,” he says. “If people can walk – if they can be pain-free on their feet – that would affect their overall health and quality of life.”

Ana Hernandez Reynoso

> Collaborations [throughout Cleveland] allow me to have the greatest impact on my research, which centers around neurostimulation for rehabilitation."
>
> **Ana Hernandez Reynoso**

When Ana Hernandez Reynoso was considering options after completing post-doctoral work at the University of Texas at Dallas, she listened to the advice of Joseph Pancrazio, her mentor and vice president of research at the university. “He told me that Case has a wonderful environment, collaborators and mentors. It has everything you need to succeed,” recalls Hernandez Reynoso.

Since joining Case Western Reserve University’s Biomedical Engineering Department in September 2024, she has discovered first-hand the accuracy of Pancrazio’s assessment. Hernandez Reynoso has fostered relationships with several professors in the department and throughout the university, as well as physicians and researchers at local hospitals, including Margot Damaser in the Department of Biomedical Engineering at Cleveland Clinic’s Lerner Research Institute.

“These collaborations allow me to have the greatest impact on my research, which centers around neurostimulation for rehabilitation,” she says. Hernandez Reynoso’s current project focuses on one of the main concerns for people with spinal cord injuries (SCI) – urinary dysfunction. Her laboratory is developing a novel approach to restoring urinary function after SCI.

“Instead of using electrodes to control when the bladder needs to void or the urethra needs to close so there is no involuntary leakage, we are teaching individuals with incomplete SCI how to regain control of their bladders through neuroplasticity,” she says.

Hernandez Reynoso uses vagus nerve stimulation to promote neuroplasticity and pairs that with bladder rehabilitation. The project is funded through a K99/R00 Pathway to Independence Award from the National Institutes of Health. In addition, she investigates strategies to improve the safety and reliability of neural interfaces for stimulation and recording.

Along with research, Hernandez Reynoso is committed to mentoring the next generation of biomedical engineers just as Pancrazio guided her. She recently became faculty mentor for the Society of Hispanic Professional Engineers at Case, and she served as faculty mentor for Iris Lai, a biomedical engineering student who won first place in the engineering division of the university’s fall 2024 Intersections undergraduate research presentation awards.

“I feel grateful to be in the position to help students,” says Hernandez Reynoso. “I really care about their interests.”

Luke Osborn

Luke Osborn grew up building things for fun, so it's no surprise he was attracted to the field of engineering in college. Now he aims to build technologies that restore, augment and enhance human function.

> Why can't we enhance our sense of touch rather than just restoring it, building a device that gives us better sensitivity or new sensations?"
>
> **Luke Osborn**

"There are lots of great examples of assistive devices that help make humans more functional – wheelchairs, glasses, prosthetic devices," says Osborn, who was appointed assistant professor in July 2024. "But it's interesting to ask why we can't go even further. Why can't we enhance our sense of touch rather than just restoring it, building a device that gives us better sensitivity or new sensations?"

Osborn was a senior researcher at Johns Hopkins University's Applied Physics Lab prior to joining Case, where he was attracted to the university's long history in neural engineering research.

"Case Western Reserve has been the leader in this space for so long and being able to be part of that is exciting," says Osborn. "I feel like I can learn from – and contribute to – all the great institutional knowledge here."

Osborn is a member of the Human Fusions Institute (HFI) at CWRU, a multi-disciplinary team of experts committed to developing human-centered, socially and environmentally responsible technologies. His lab at HFI will build artificial skins for robots and other neuroengineered technologies that interface with humans, then measure and try to understand how that interaction affects humans. It's an extension of the work Osborn began as a graduate student when he developed e-dermis artificial skin. When placed over the fingertips of a prosthetic, it mimics nerve endings and facilitates a sense of touch. It can also be placed onto robots to allow them to feel things.

"What gets really interesting is how we can connect a neuromorphic e-dermis to provide new types of feedback to a human who is controlling that robot, whether it's a prosthetic limb, a teleoperating surgical robot or an astronaut controlling the Mars Rover," he says.

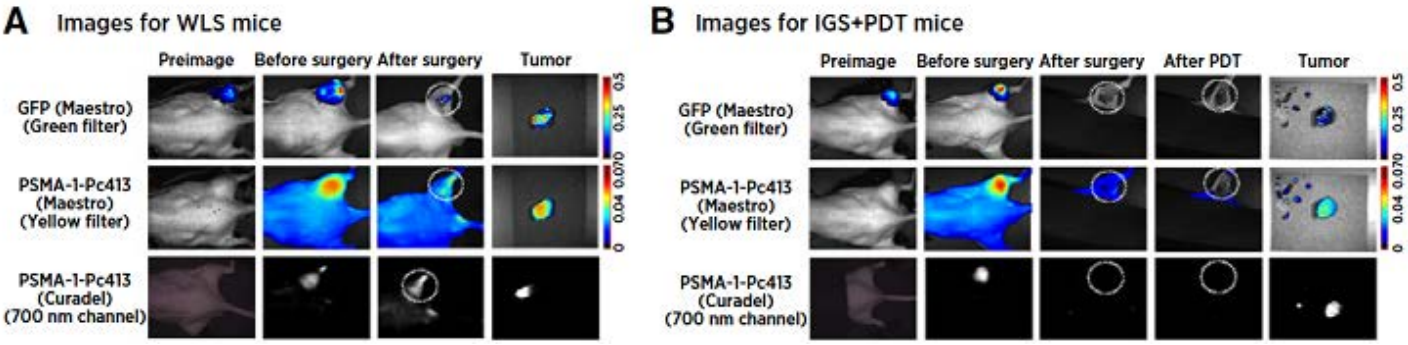
Osborn's groundbreaking research has garnered several accolades in his young career. He was named to Forbes 30 Under 30 – Science list in 2019, and the e-dermis team earned the Misha Mahawold Prize for Neuromorphic Engineering in 2022. While the recognition is gratifying, it's not the driving force behind Osborn's work.

"Ultimately, we're trying to figure out how these new technologies impact the way the human brain works – how people behave and function," he says.

Pioneering Advancements in Prostate Cancer

Investigators at the Center for Imaging Research aim to transform diagnostics and therapeutics

Aayushi Laliwala, left, postdoctoral scholar and lab manager of the Exner Lab and Tessa Kosmides, PhD candidate in biomedical engineering at Case Western Reserve University.



Prostate specific membrane antigen (PSMA), overexpressed on most prostate cancers, can be targeted by the theranostic agent PSMA-Pc413 to allow for fluorescence-guided surgery (FIGS) and adjuvant photodynamic therapy (PDT). These images depict mice receiving white light surgery (A) and image-guided surgery (B) under Maestro and Curadel imaging systems. The circles indicate surgical beds.

The vision of the Case Western Reserve University Center for Imaging Research (CCIR) is to lead the next generation of transformative imaging research that will radically improve disease prevention, diagnosis and therapy. One of the diseases targeted by CCIR's multidisciplinary investigators is prostate cancer.

"Prostate cancer is an insidious disease – the most prevalent cancer among men in the United States and the No. 2 killer in men," says James P. Basilion, a CCIR researcher and professor of biomedical engineering and radiology. "While the diagnostic and therapeutic approach to prostate cancer has been revolutionized, a lot of work still needs to be done."

James P. Basilion

Basilion and several of his colleagues at CCIR are developing new technologies and tools to advance the field with modalities including magnetic resonance imaging, magnetic resonance fingerprinting, ultrasound and others. Here are four of their cutting-edge projects focused on prostate cancer:

Preventing a Toxic Side Effect of RLT

Traditional radiation therapy is delivered via external beam irradiation, which travels through the body on route to the tumor. The development of targeted radioligand therapy (RLT) – which attaches a radionuclide to a ligand that binds to prostate-specific membrane antigen (PSMA) – delivers treatment directly to the tumor and spares radiation to healthy tissues and organs.

"RLT is currently enjoying great commercial success for treatment of prostate cancer," says Zhenghong Lee, a professor of radiology and biomedical engineering. "However, an unexpected toxic side effect quickly surfaced as patients complained about having severe dry mouth, making it difficult to eat, swallow and speak."

Zhenghong Lee

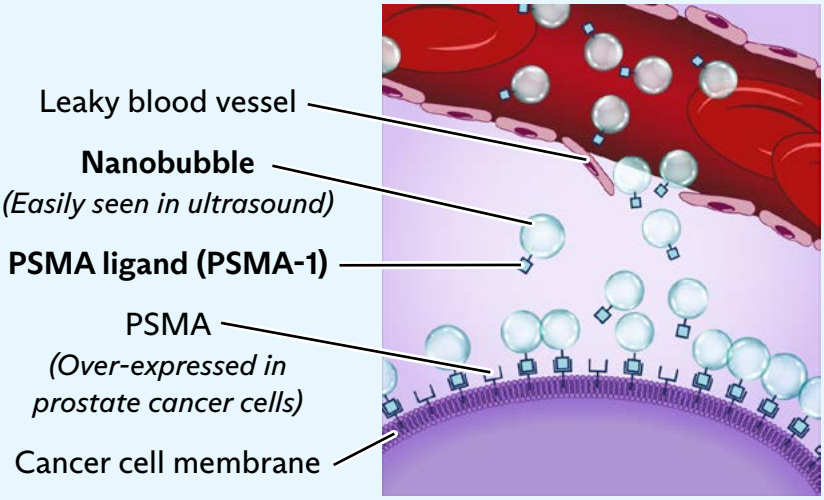
There are no remedies for targeted RLT-induced xerostomia. Lee and his colleagues, including Basilion, are developing an approach to prevent the side effect.

"We have discovered that a small molecule inhibitor – a shield – can protect the salivary glands and prevent dry mouth during RLT," says Lee. The aim of the research is threefold:

- To optimize the salivary blocking effect based on biodistribution and radiation dosimetry.
- To examine toxic profiles of the shield to prepare it for clinical translation.
- To further test the improvement in alpha/beta particle therapies with salivary protection.

The team has completed preclinical and therapy experiments, as well as a two-species toxicology study for the inhibitor showing a favorable safety profile.

"Currently, RLT is a last resort when patients fail all available treatment options," says Lee. "If proven clinically successful, our shield could be used so that many existing targeted RLTs could move forward for more aggressive treatment as a frontline or second-line treatment."



Agata Exner's research centers around nanobubbles – nanoparticles with gas at their core. By stimulating the nanobubbles with sound waves, she hopes to improve cancer detection and targeted therapy. Joining PSMA-1 with nanobubble contrast agents offers promise for one of Exner's focus areas – ultrasound imaging of prostate cancer.

Improving Image-Guided Biopsies

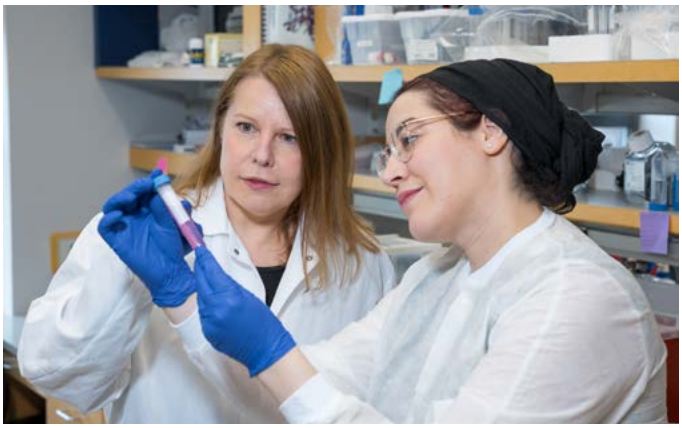
Xinning Wang, a research associate professor in the Department of Biomedical Engineering and a member of Basilion's lab, has developed an improved PSMA-binding molecule for use as a targeted theranostic agent for fluorescence-guided surgery and photodynamic therapy. "We designed our ligand – PSMA-1 – so that it has better selectivity, better specificity and less off-target binding," says Basilion.

Xinning Wang

Basilion is now using PSMA-1 to "begin to approach problems that others haven't approached," he says. Being a part of the multidisciplinary imaging research community at CCIR expedites that work. One of his latest collaborations is with Agata Exner, faculty director of CCIR, the Henry Willson Payne Professor and vice-chair for basic research in radiology, and a professor of biomedical engineering.

Agata Exner

Exner's research centers around nanobubbles – nanoparticles with gas at their core. By stimulating the nanobubbles with sound waves, she hopes to improve cancer detection and targeted therapy. Joining PSMA-1 with nanobubble contrast agents offers promise for one of Exner's focus areas – ultrasound imaging of prostate cancer.



Agata Exner, left, and Salima El Yakhlifi, a former postdoctoral scholar in the Exner Lab.

Some of the limitations of traditional ultrasound-guided prostate biopsies include poor spatial resolution and limited sensitivity, which can lead to challenges in identifying and characterizing tumors.

"We found that combining the PSMA-1 ligand with nanobubbles, which can be visualized with ultrasound imaging, we can bind to cancer within the prostate gland," says Basilion. "We can get a signal-to-noise background ratio that makes it possible to visualize the tumor over the normal prostate tissue, allowing for better image-guided biopsies."

The researchers launched the startup company Visano Theranostics to further develop the theranostic agent.

Reducing Unnecessary Biopsies

Yong Chen's research also focuses on prostate biopsies, specifically reducing unnecessary procedures. Approximately 30% of patients with a negative MRI for prostate cancer end up getting a biopsy due to

suboptimal negative predictive values with current MRI techniques. This leads to unnecessary biopsies and post-procedure complications.

Chen's team is developing a fast diffusion magnetic resonance fingerprinting (MRF) technique. "Unlike conventional imaging methods which provide qualitative tissue contrasts, MRF can generate precise tissue property measurements, allowing for more comprehensive tissue and disease characterization," says Chen, an assistant professor of radiology.

Yong Chen

His team has pioneered an MRF technique that enables accurate quantification of T1 and T2 relaxation times in prostatic tissues. "Our preliminary data suggests that this approach could help reduce unnecessary biopsies by approximately 60% in patients with a negative MRI," says Chen.

Water diffusion is another critical tissue property that could further improve prostate cancer detection and grading. As part of a 5-year, $3.1 million award from the National Cancer Institute, Chen and his CCIR colleague, the project's Principal Investigator Leonardo Kayat Bittencourt, MD, PhD, vice chair of innovation in the Department of Radiology at UH Cleveland Medical Center, along with Dan Ma, associate professor of neurosurgery and biomedical engineering at Duke University, will optimize the prostate MRF technique for T1, T2 and diffusion quantification.

"The ultimate goal of this project is to develop a multivariable predictive model that integrates MRF-derived quantitative values with patient clinical information," says Chen. "Based on this tool, clinicians can more accurately and objectively rule out prostate cancer, reduce unnecessary biopsies, minimize potential complications and lower healthcare costs for patients with a negative MRI."

Developing Minimally Invasive Surgical Procedures

Researchers at Case Western Reserve University and Vanderbilt University are pioneering a new approach to prostate cancer surgery by combining low-field MRI techniques with a surgical robot. The goal is to replace radical prostatectomy with minimally invasive focal resection of prostate cancer.

"Targeted removal of localized prostate lesions could alleviate complications associated with total prostate gland removal, but it is challenging because cancerous tissue can appear identical to healthy tissue in endoscopic images, making accurate surgery difficult," says William Grissom, the Medtronic Professor of Biomedical Discovery and Innovation at Case Western Reserve School of Medicine and a professor of biomedical engineering. Grissom and Robert Webster, the Richard A. Schroeder Professor of Mechanical Engineering at Vanderbilt, are leading the collaborative project, which received a five-year, $3.7 million grant from the National Institutes of Health. The innovative surgical approach hinges on two components – a robot from Virtuoso Signals Inc., a startup founded by Webster, and a low-field MRI scanner from Promaxo Inc. Grissom and Webster will adapt the robotic device, which was originally built for holmium laser enucleation of the prostate (HoLEP), a total prostate resection via a transurethral procedure.

William Grissom

"The robot is currently only suitable for removing the whole prostate because it can't see lesions," says Grissom. "In order to excise only the cancerous part of the prostate, they need some additional information." That's where the low-field MRI scanner comes into play.

The team will combine high-field magnetic resonance images obtained prior to the procedure with real-time images gathered continuously from the low-field MRI scanner during the procedure.

"We know that low-field MRI doesn't have enough contrast to show the lesions clearly on their own," says Grissom. "But they have similar contrast to the high-field images, so we should still be able to see landmarks and do a better job of registering those two images together than going across modalities, such as ultrasound-MRI fusion."

The adapted robot will carefully guide two needle-sized manipulators through a standard transurethral endoscope directly to the lesions identified on the high-field images.

"This will make the focal resection process much easier and more accurate for the surgeon," says Grissom. "The system will enable personalized resections for patients who today have no alternative to radical prostatectomy."

A Pacesetter in Neural Engineering

Dominique Durand has dedicated his career to solving problems in the nervous system

While Dominique Durand trained as an electrical engineer as an undergraduate student in his home country France, he has devoted his career to neural engineering. The transition makes sense to Durand, a professor in the Case Western Reserve University Department of Biomedical Engineering, Department of Neurosciences and Department of Physiology and Biophysics.

"I like circuits of any kind, and the brain is a circuit," says Durand, who also serves as director of the Neural Engineering Center in the Case School of Engineering School of Medicine. "When I started working in the lab at the Playfair Neuroscience Unit at Toronto Western Hospital, it was the first time we were able to put an electrode directly into a single neuron for intracellular recordings. We could see the resting potential, the action potential – it was fascinating."

Durand's work as a research associate at the hospital and a scientist in the Neurology Program at the Addiction Research Foundation in Toronto influenced his decision to study at the Institute of Biomedical Engineering within the Department of Electrical Engineering at the University of Toronto. After earning his doctorate degree, he joined Case Western Reserve University as an associate professor of biomedical engineering in 1983.

Research Aimed at Controlling Epilepsy

Durand initially planned to remain in Toronto after earning his PhD.

"I was going to stay there as a biomedical engineer. But I was walking down the halls at University of Toronto and saw an ad for an assistant professor position in Cleveland," he recalls. "My wife is from Cleveland, so it was an easy decision."

Leaving the northwestern shore of Lake Ontario for the banks of Lake Erie represented a return home not only for Durand's wife, but in part for him, too. He earned a master's degree in biomedical engineering from Case in 1975.

During his 42 years as a faculty member in the department, Durand has combined neuroscience, engineering and electrophysiology to solve problems in both the central and peripheral nervous systems. His research findings have been published in more than 450 journal articles. The most recent article in the March-April 2025 issue of *Brain Stimulation* is related to Durand's lifelong research in epilepsy.

Durand and his peers shared results of a study indicating that the generation and propagation of epileptic events – such as spikes and seizures – can be completely suppressed by controlling the extracellular voltage within the focus with small amounts of current. The researchers investigated the mechanisms that explain the suppression.

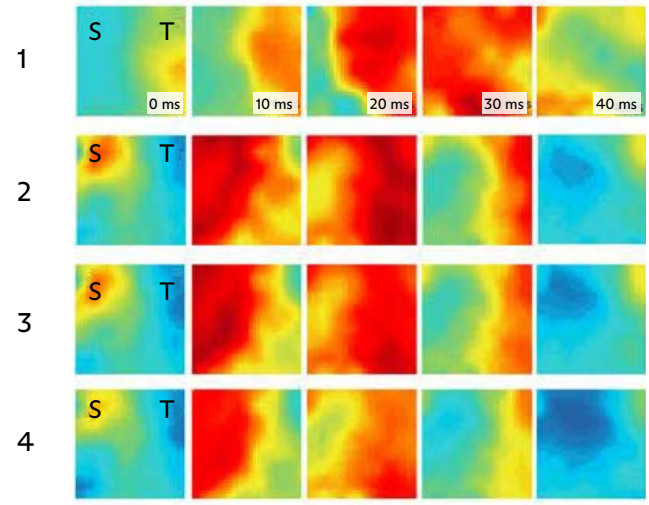
"Communication between neurons across the brain can occur through ephaptic coupling, where electric fields are generated by neurons that activate their neighboring neurons," says Durand. "We took advantage of that phenomenon and examined what happens if we generate an electric field of our own that is exactly opposite of what the brain generates during a seizure."

While the team doesn't yet fully understand the mechanism of action and the results in this study were limited to a small focal region, the technology shows potential as a therapy for controlling focal epilepsy.

Breakthrough Technology for Neural Interfacing

For decades, Durand's research on the peripheral nervous system has focused on recording neural activity in fascicles, which are only approximately 200 microns in diameter. The team initially experimented with cuff electrodes for neural interfacing.

"It turns out that works great for electrical stimulation, but it's much more difficult for recording because the signals are very low amplitude and not very selective," says Durand. "I figured the only way to extract



Neural activity propagating without synaptic transmission by ephaptic coupling.

signals was to put an extremely flexible electrode inside the fascicles."

He developed a flexible yarn electrode made of carbon nanotubes (CNTs) with axon-like dimensions – only about 10 microns in diameter – facilitating a direct interface with the peripheral nervous system. The research team has conducted in vivo studies and successfully implanted a probe made of CNTs in several nerves, including the glossopharyngeal nerve and sciatic nerve.

"We were able to record for the first time ever from the vagus nerve in a rat," says Durand. "We were never able to do this before because all of the previous probes were too big and too stiff."

The technology offers promise for robotic prosthetic devices that can be controlled by the nervous system. Most user-controlled devices rely on electromyography (EMG) pads that attach to the skin, record electric activity in muscles and generate signals that provide direction to the prosthetic limb to move.

"However, those muscles are only above the amputation, while the nerves are still there to carry all the necessary signals from the brain," says Durand. "We are trying to extract those signals and control the prosthetic device."

A Passion for Learning and Teaching

Durand is equally committed to instructing and mentoring the next generation. He teaches undergraduate courses in bioelectric phenomenon and instrumentation and analysis.

"I am passionate about understanding concepts," says Durand. "For me, this material is really cool. Every time I go through it, I find something I didn't completely understand, and I try to dig into it with my students."

Durand also helped launch Case Western Reserve University's online master's in biomedical engineering program and serves as its director. The program retains the same emphasis on projects and problem-solving as the in-person program.

"We're using software that simulates nearly exactly what it would be like in the lab," says Durand. "We can actually decide what problems we want to solve ahead of time and teach those skills in a better way. Problem-solving in the field is what excites me, and it's possible to do that online."

The online option provides opportunities for many students that might not otherwise be able to pursue an advanced degree, such as Ciera McCrary. She was a Navy lieutenant on active duty aboard the USS Howard out of San Diego while enrolled in the online master's program in 2020.

An Enduring Impact on Students

Durand began his career in biomedical engineering 50 years ago as a clinical engineer at a hospital in Quebec, Canada. His drive to continue researching and teaching stems from a desire to contribute more to the field.

"What have I done? Yes, I published a lot of papers, but it's not clear the impact those have," muses Durand. "A better impact is the people who came through the lab that now have amazing careers. Perhaps I have had something to do with that."

Former students say Durand has most certainly contributed to their careers.

"Durand's mentorship profoundly impacted my own practice as a professor in every possible way, from the subjects I research and how I approach problems to how I manage the lab and support students," says Marom Bikson, professor of biomedical engineering at the City College of New York.

Bikson conducted research on the mechanisms of direct current brain stimulation in Durand's lab while earning his doctorate degree at Case Western Reserve University from 1996 to 2000.

"Durand's office door was always open, and he was ready to carefully listen to concerns and progress and provide great insight on the next steps," says Bikson. "I had confidence that if anyone could point me in the right direction, it was Durand."

Five Decades of Restoring Upper Extremity Movement with Neuroprostheses

On Jan. 10, 2025, nearly 300 attendees gathered in person – and 60 more joined online – to celebrate five decades of research into restoring upper extremity movement with neuroprosthetic devices and rehabilitation programs developed in Cleveland. The event, sponsored by the Cleveland FES Center, Department of Biomedical Engineering at Case Western Reserve University and MetroHealth Medical Center, brought together more than 20 experts reflecting on past innovations and their experiences. They also provided insight on recent breakthroughs and future research needs.

P. Hunter Peckham, founding director of the Cleveland FES Center and a driving force behind its legacy, delivered the keynote address. In a moving presentation, Peckham honored mentors such as J. Thomas Mortimer and Lojze Vodovnik, celebrated the many contributors to the center's success and shared his vision for continued progress. His words served as a powerful reminder of the impact that dedication and innovation can have on real lives. Missed the event? You can watch the symposium on YouTube here.

Lived Experience Panel Discussion

Moderators: Kim Anderson, professor, and Anne Bryden, associate professor, from the Department of Physical Medicine & Rehabilitation at the Case Western Reserve University School of Medicine and MetroHealth Center for Rehabilitation Research.

Panelists: Annette Coker, Woody Brooks, Maria Sutter, (not pictured: Jeanette Green)

Lunch & Fireside Chat

From left: Geoff Thrope, president, CEO and managing director of The Mariah Fund Inc.; P. Hunter Peckham, founding director of the Cleveland FES Center; and Megan Moynahan, executive director of the Institute for Functional Restoration.

Jennfier French speaks as a panelist during the session, *Long Term Support of Individuals who Receive Neuroprosthetic Devices,* moderated by Ron Triolo, a professor in biomedical engineering at Case Western Reserve University and executive director of the Advanced Platform Technology Center.

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