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VANDERBILT BIOPHOTONICS CENTER
VOL. I | ISS. II

Image by: Kanchana Devanathan, PhD

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2024 GORDON RESEARCH CONFERENCE: OPTICS AND PHOTONICS IN MEDICINE & BIOLOGY - A PERSPECTIVE FROM THE CONFERENCE CHAIR

Since its inception in 1965, the Gordon Research Conference on Lasers in Medicine and Biology (recently renamed Optics and Photonics in Medicine and Biology) has been a beacon for early-stage biomedical optics technologies. As one of the longest-standing GRCs, it has consistently fostered innovation and collaboration among researchers and students, drawing them to its intimate setting for profound scientific exchanges and the cultivation of lasting professional relationships.

The 2024 Gordon Research Conference on Optics and Photonics in Medicine and Biology (OPMB) was successfully held at Bates College, Lewiston, Maine, USA. This year's conference theme was 'From Fundamental Physics to Applied Physiology.' This conference was co-chaired by E. Duco Jansen (Vanderbilt University, Nashville, TN, USA) and Snow Tseng (National Taiwan University, Taiwan) with the help of Prof. Maurice Aalders (University of Amsterdam, The Netherlands). With the participation of researchers from all over the world, senior scientists, and early career scientists (including graduate students and postdocs, who made up nearly half of the conference attendees), we had a very fruitful conference from July 6-12, 2024. July 6th reserved for the Gordon Research Seminar, a day-long session organized by graduate students and postdocs specifically for graduate students and postdocs.

XXX Interestingly and probably somewhat uniquely, for the past eight years, a Vanderbilt VBC faculty (and a member of the Jansen household) has been either vice-chair or chair of this conference, with Prof. Anita Mahadevan-Jansen serving as vice-chair in 2016, chair in 2018 and Prof. Duco Jansen serving as vice-chair in 2022 and chair in 2024 (2020 conference was canceled). This year's conference was also significant as it marked the first time since the founding of this conference in 1965 that an Asian-based researcher (Dr. Snow Tseng) served as conference co-chair. This historic milestone reflects a broader shift in the global landscape of biomedical optics and highlights the growing influence of Asian research. We are honored to be part of this transformative moment and committed to showcasing cutting-edge advancements while fostering meaningful connections within the international scientific community.

(left) Invited speaker, Prof. Claus-Peter Richter, MD PhD, Department of Otolaryngology-Head and Neck Surgery, Northwestern University; (middle) co-Chair E. Duco Jansen, Senior Associate Dean, Professor of Biomedical Engineering and Neurological Surgery, Vanderbilt University; (right) co-Chair Snow Tseng, Distinguished Professor, Leadership Program, National Taiwan University.

This year, we had a terrific, stimulating, and diverse conference that featured 29 invited talks and ensuing discussions that nine different discussion leaders led. Nearly a third of the speakers/discussion leaders were from outside the US, and 42.5% were female, something that, as chairs, we were particularly excited about (we've come a long way from the first GRC that I attended in 1992). Overall, ~ 50% of the conference attendees were graduate students or postdocs, a hallmark of the Gordon Conferences. Last but not least, one of the responsibilities of the conference chairs is to raise funding for the conference to support the registration fees and travel of speakers and early career attendees (and to pay for the drinks and snacks during the poster sessions and evening social events). Thanks to the generous contributions of several federal funding agencies (NIH, NSF, and AFOSR) as well as corporate sponsors and even some educational institutions (including our own VBC), our fund-raising efforts were quite successful (putting this particular GRC in the top 5% of all GRC's this year as far as fund-raising).

On a personal note, I first attended this particular conference as a second-year PhD student (in 1992) and have attended every single one since then (so with this being a biannual conference, this was my 16th GRC). It was a truly transformative experience at that point in my career, and several of the people I met at that conference more than three decades ago have been colleagues and friends ever since. I hope this year's conference will have had the same impact on some of the attendees.

By: Duco Jansen (GRC-OPMB 2024 co-chair)

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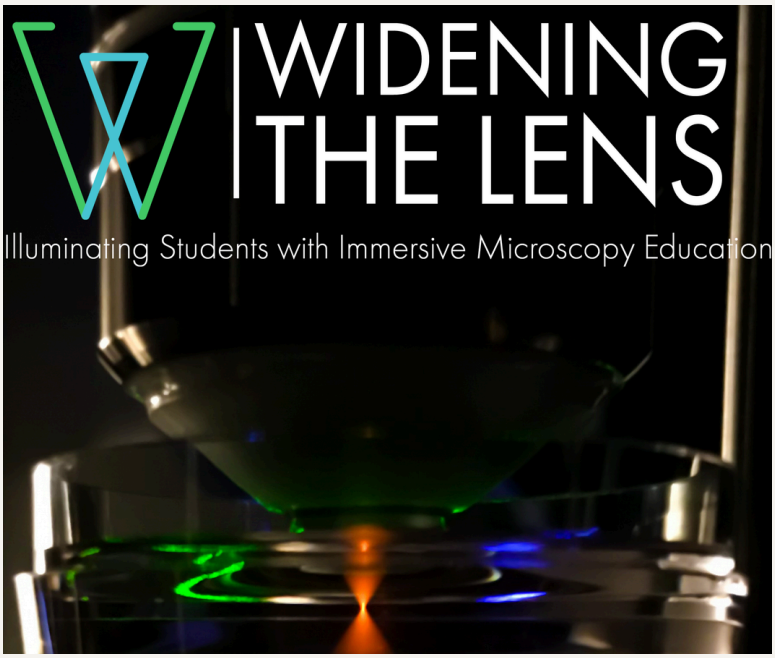
WIDENING THE LENS

Dr. Bryan Millis – the Associate Director of Science and Technology at the VBC – is known for designing and building advanced optical microscopes at Vanderbilt, but his heart is with enabling researchers at low resource institutions. His work in this space was jump started when in 2020 Dr. Millis received a grant from the Chan Zuckerberg Initiative (CZI) to create educational optical imaging content for students and faculty at institutions lacking such expertise. This initiative led to the development of a class called Widening the Lens.

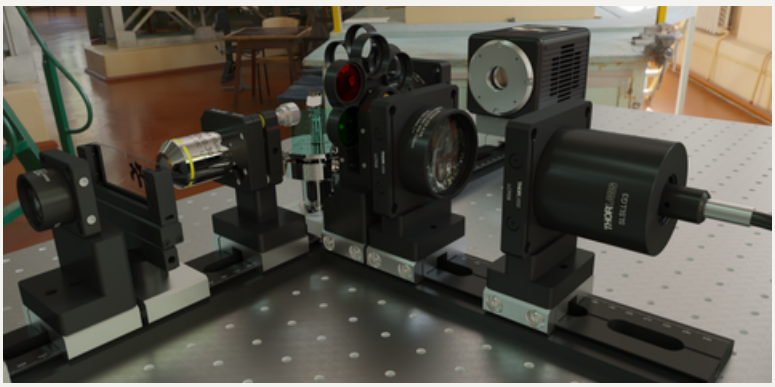
The grant from CZI was unique in that it was not designed to fund an idea but rather a promising researcher, which allowed Millis the freedom to experiment with different ideas in an effort to improve student learning. Initially, he built simple microscopes in his office-turned-recording studio to demonstrate concepts like collimation and image detection. However, Millis soon realized that providing sufficient insight using different camera angles was clunky and cumbersome. To streamline his recording process and student learning, he turned to Blender, a computer graphics software often used for creating animated films and commercials. Using CAD files from ThorLabs, he could quickly build setups and render them realistically, providing viewers with a detailed depiction of how a microscope works.

However, while some of the class's growth has been the result of necessity, much of it has been the natural advancing of the program. The class transitioned from synchronous to a flipped classroom to aid in material absorption and make the learning applicable to students as quickly as possible. By the end of year two, though, Millis was surprised to see the degree to which others craved imaging knowledge – particularly from international developing economies. The rapid increase in the popularity of the class and his desire to deliver increasingly meaningful material to his students of vastly different backgrounds led him to bring in other researchers specializing in various imaging techniques. Dr. Millis has emphasized how incredibly impactful it is for his students to gain the ability to speak to top researchers and companies.



This year's significant development is the partnership between Widening the Lens and the African BioImaging Consortium (ABIC) to bring a Teaching the Teacher model to African researchers from Nigeria, Egypt, Rwanda, South Africa, and Kenya. At the end of each month, after having watched the lecture videos, a conversation with guest lecturers will be hosted, aiming to equip students to teach other researchers at their university or organization. This shift signifies a move toward preparing students to disseminate knowledge and accelerate the deployment of research methods in these regions for on-the-ground disease detection and study.

By: Parker Willmon



A Blender rendering of ThorLabs optical components in virtual space.

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NEW GRADUATE STUDENTS

By: Anna Funderburg

Trey Dobson

Atlanta, GA

Georgia Institute of Technology, Biomedical Engineering

A native of Atlanta, GA, Trey joins the VBC after feeling at home at Vanderbilt during his recruitment visit. Trey comes to Nashville with his cat named Ziggy and is looking forward to exploring Nashville.

Viannely Francisco

North Providence, RI

Roger Williams University, Electrical and Computer Engineering

Attracted to graduate school to deeper her understanding of biomedical engineering and drive meaningful change and impact in the world, Viannely joins the VBC as a graduate student. Viannely additionally proudly represents her family's Dominican heritage while at Vanderbilt.

Vivian Krause

Glastonbury, CT

Elon University, Engineering with a Biomedical Concentration

Vivan joins the VBC to break into the world of optics and gain expertise in medical device and diagnostic design. When visiting Vanderbilt, the VBC felt like home and the PhD program offered a blend of everything she was looking for. Vivian is an avid Spotify user and was in the top 0.5% of SZA listeners for 2023.

Meagan McKee

San Antonio, TX

Trinity University, Engineering Science

Meagan joins the VBC with an interest in developing optical technologies that can improve the patient care. She was excited by the sense that the faculty at Vanderbilt loves their research and mentoring students. Outside of the lab, Meagan is a musician and has played the cello for 11 years.

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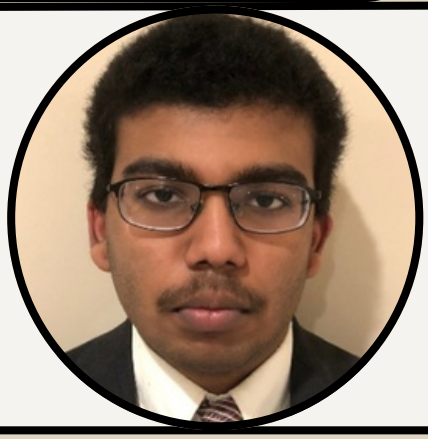
NEW GRADUATE STUDENTS

Mayaank Pillai



Hillsborough, NJ

Vanderbilt University, Computer Science

Mayaank, a PhD student in computer science, is eager to explore vision and machine learning applications in medical imaging under the guidance of Dr. Audrey Bowden. In the past 3 years, Mayaank collaborated with Rachel Eimen, assisting in the development of an assessment and feedback pipeline and hardware for the clinical implementation of Rachel's dissertation work on 3D bladder reconstructions (*for more details, see the VBC Spotlight*).

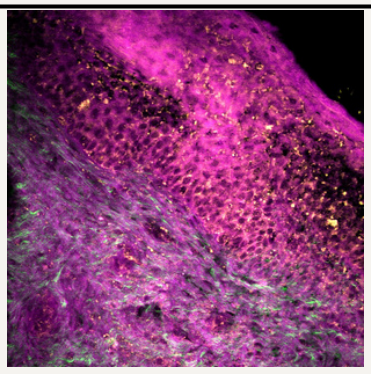
Luke Whitehead

Lake Jackson, TX

University of Oklahoma, Biomedical Engineering

Luke joins the VBC to prepare himself for a research focused career. He was drawn to the VBC for the sense of community and the idea of being part of a center as opposed to just a lab. Luke is from the home of Buc'ees and is looking forward to the establishment's advance to the Nashville area.

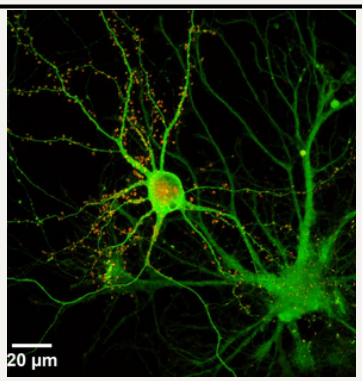
LIGHT FRAMES: PICTURING BIOPHOTONICS



Stimulated Raman Scattering (SRS) and Second Harmonic Generation (SHG) Microscopy Image Composite of a Mouse Cervix

Color Description: Magenta - Protein and DNA (λp = 796 nm, λs = 1030 nm) and Yellow - Lipid (λp = 788 nm, λs = 1030 nm), Green - Collagen (λe = 800 nm), where λp, λs and λe are pump beam, stokes beam and excitation beam respectively.

Courtesy of:
Kanchana Devanathan, PhD



Fluorescence image of a cortical neuron (left) and astrocyte (right) cultured in vitro for 21 days

Both cells are expressing GFP while only the neuron is expressing the fluorescence-tagged PSD-95, localized to the tips of dendritic spines of the neuron.

Courtesy of:
Jacob Hardenburger

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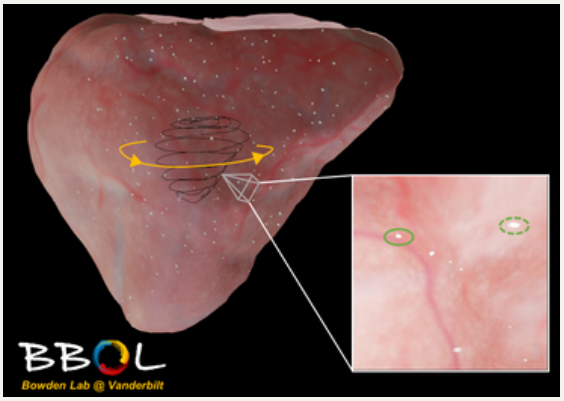
VBC SPOTLIGHT

Rachel L. Eimen, PhD

By: Alex Cousart

On September 20th, 2024, Rachel Eimen successfully defended her PhD dissertation, “Software tools to enable 3D bladder reconstruction from clinical white light cystoscopy videos”. Dr. Eimen has spent the past 5-years working on this groundbreaking software to improve the cystoscopy data that clinicians use to treat and inform surgery for bladder cancer patients. Her dissertation aimed to improve the quality of 3D bladder reconstructions by enabling 3D reconstruction of the bladder from fiberscope-based cystoscopy videos, developing clinical software that provides real-time feedback to improve the quality of acquired videos, and creating a virtual cystoscopy simulator to further assist the development of 3D reconstruction algorithms.

These aims of her work resulted in the creation of a novel metric for reconstruction coverage a novel algorithm for cystoscope pattern removal, am assessment and feedback pipeline to perform real-time clinician feedback for frame recollection, and the creation of a realistic bladder debris and motion blur model.



Realistic 3D bladder reconstruction with stationary bladder debris (solid oval) and blurred debris (dashed oval)

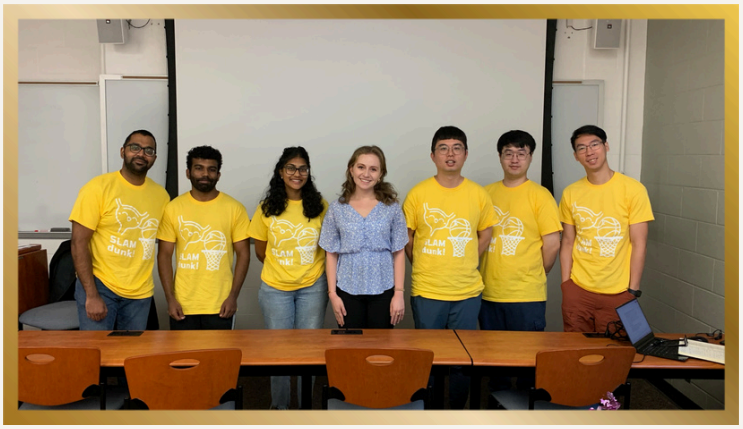
Courtesy of: Rachel Eimen, PhD

Publications:

Eimen, R.L., Krzyzanowska, H., Scarpato, K.R. and Bowden, A.K., "Fiberscopic pattern removal for optimal coverage in 3D bladder reconstructions of fiberscope cystoscopy videos," J. Med. Imag. 11(3) 034002 (2024)

Eimen, R.L., Pillai, M., Scarpato, K.R. and Bowden, A.K., "Towards improved 3D reconstruction of cystoscopies through real-time feedback for frame reacquisition," Biomedical Optics Express, Vol. 15, Issue 5, pp. 3394-3411 15(5), 3394–3411 (2024).

Eimen et. al., "A virtual simulator for cystoscopy containing motion blur and bladder debris to aid development of clinical tools," Biomedical Optics Express (accepted).



Bowden Biomedical Optics Lab. From left to right: Anupam Kumar, Mayaank Pillai, Manasa Sripati, Rachel Eimen, Yunqin Zhao, Xiao Tang, Daniel Phan

FOLLOW US

ANNOUNCEMENTS

Congratulations to Seth Crawford and Jake Watson for passing their PhD qualifying exams!

Congratulations to Jake Watson and the Tao lab for their artwork being chosen for the cover of the Journal of Biomedical Optics, volume 29.

Welcome Rafay Ahmed & Manasa Sripati to the VBC!

UPCOMING EVENTS

VBC Seminar Series:

October 8 - Hoy Lecture with Murray Johnstone & Ricky Wang (University of Washington)
October 22 - Daniel Gonzales (Vanderbilt University)
October 29 - Ethan LaRochelle (QUEL Imaging)
November 5 - Vasan Venugopalan (UCI)
November 12 - Laura Marcu (UCD)
November 26 - Loïc Royer (CZI Biohub)
December 3 - Gracie Vargas (UTMB)

RECENT PUBLICATIONS, PRESENTATIONS, AWARDS, & FUNDED GRANTS

Publications

- *Characterization of vaginal Lactobacillus in biologically relevant fluid using surface-enhanced Raman spectroscopy*
  - *Anna Rourke-Funderburg, Anita Mahadevan-Jansen, Andrea Locke*
- *Optimization of handheld spectrally encoded coherence tomography and reflectometry for point-of-care ophthalmic diagnostic imaging*
  - Jacob Watson, Rachel Hecht, Yuankai (Kenny) Tao
- *Impact of scattering phase function and polarization on the accuracy of diffuse and sub-diffuse spatial frequency domain imaging*
  - *Alec Walter, Duco Jansen*
- *Suppressing sidechain modes and improving structural resolution for 2D IR spectroscopy via vibrational lifetimes*
  - *Kayla Hess, Lauren Buchanan*

Presentations

International Conference on Raman Spectroscopy 2024

- "Detection of vaginal Lactobacillus using surface-enhanced Raman spectroscopy (SERS)", Anna Rourke-Funderburg
- "Challenges to translating Raman spectroscopy", Anita Mahadevan-Jansen

10th Annual Emerging Vision Scientists Program

- "Importance of fundamental research in traumatic brain injury", Pratheepa Rasiah (advocacy talk)
- "Microglial modulation in traumatic brain injury", Pratheepa Rasiah

Military Health System Research Symposium 2024

- "Correlating High-Wavenumber Raman Spectra to Hydration Status in High Performance Individuals", Richard Liao

Gordon Research Conference on Optics and Photonics in Medicine and Biology

- "*Probe-Based Near-Infrared Autofluorescence for Enhanced Parathyroid Detection: Multi-Center Randomized Clinical Trial*", Alexandria Cousart
- "*Assessment of Fibrillar Collagen Orientation in the Upper and Lower Cervix using Second Harmonic Generation Microscopy*", Kanchana Devanathan
- "*A Dual Modality Miniaturized Handheld Imaging System: Fluorescence and Laser Speckle Contrast Imaging for Parathyroid Identification and Vascularity Assessment*", Han Dong
- "*An improved virtual simulator for clinical cystoscopy*" , Rachel Eimen
- "*Evaluating the Effects of Infrared Neural Stimulation on Dendritic Spines of Cortical Neurons in vitro*", Jacob Hardenberger
- "*NIR-Guided Endocrine Surgery*", Colleen Kiernan
- "*Differentiation and characterization of bacteria using high-wavenumber Raman spectroscopy*", Alec Walter
- "*Scattering Phase Function and Polarization on Accuracy of Diffuse and Sub-Diffuse SFDI*", Alec Walter

Awards

- Anna Rourke-Funderburg was awarded a travel grant from the Vanderbilt University Graduate School to support her travel to Rome, Italy to present at the International Conference on Raman Spectroscopy.
- Pratheepa Rasiah received the Emerging Vision Scientist 2024 Award at the 10th Annual Emerging Vision Scientists Program organized by National Alliance for Eye and Vision Research (NAEVR) / Alliance for Eye and Vision Research (AEVR)

Funded Grants

- Richard Haglund, NSF EAGER: Entangled light generation via the dynamical Casimir effect
- Lauren Buchanan, NIH MIRA: Probing protein structure and aggregating in complex environments with 2D IR spectroscopy