



Center for Biomedical
OCT Research

NORTHEAST

SYMPOSIUM ON BIOMEDICAL OPTICS

OCTOBER 15TH, 2024

PROGRAM

MIT BUILDING E25
45 CARLETON ST.
CAMBRIDGE, MA





Center for Biomedical
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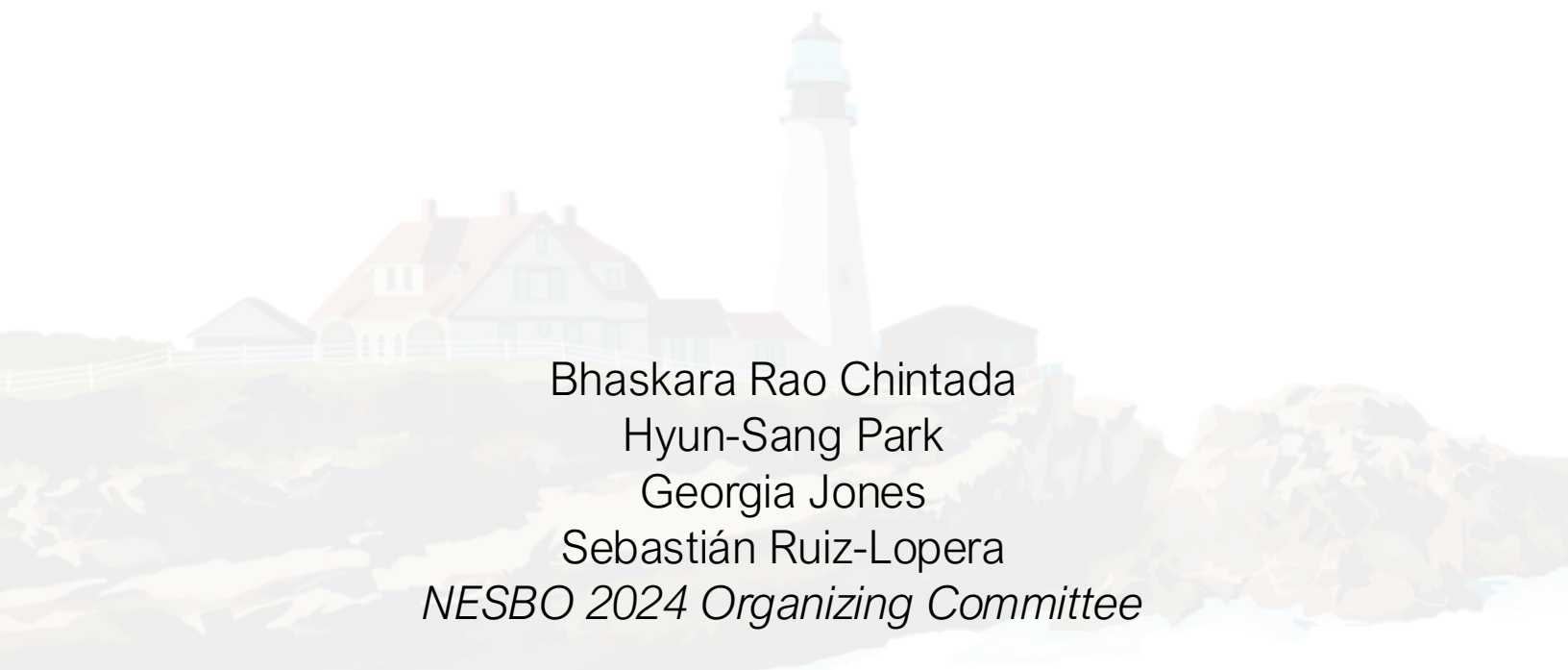
Welcome

It is our pleasure to welcome you to the seventh Northeast Symposium on Biomedical Optics. NESBO is an informal one-day symposium that is run by graduate students and postdocs, for graduate students and postdocs.

Events such as these only work with the participation of those like you, so we would like to thank you in advance for your contributions.

We acknowledge that the biomedical optics community in the northeast is large and diverse. For this year's edition we decided to allocate time for the speakers to give a brief overview of their research centers or institutions. Be prepared to learn about the resources and the opportunities for collaboration that are out there.

Ask questions, meet people, find opportunities and network!



Bhaskara Rao Chintada
Hyun-Sang Park
Georgia Jones
Sebastián Ruiz-Lopera
NESBO 2024 Organizing Committee



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About CBORT

The Center for Biomedical OCT Research and Translation (CBORT) is a National Biomedical Technology Resource Center funded by the National Institute of Biomedical Imaging and Bioengineering (NIBIB). CBORT comprises research groups of the Wellman Center for Photomedicine, which is located at the Massachusetts General Hospital in Boston. The mission of CBORT is to enable breakthroughs in biology and medicine through advancements in Optical Coherence Tomography (OCT) technology. We pioneer technical innovations to improve structural and functional OCT imaging and we provide access to OCT instrumentation to benefit our collaborators' imaging needs. An important aspect of our mission is to establish and cultivate collaborations and offer training to user communities.



National Institute of
Biomedical Imaging
and Bioengineering

CBORT is supported through the National Institute of Biomedical Imaging and Bioengineering (NIBIB) of the National Institutes of Health (NIH) – award P41EB015903.

Visit the CBORT website at www.octresearch.org



Location



MIT BUILDING E25
45 CARLETON ST.
CAMBRIDGE, MA

NESBO 2024 will be hosted at
MIT Building E25, very close to
Kendall Square Red-line T-station.

Once you arrive to the building
you will see the registration table
in the first-floor lobby.



Program

- 08:30 **Coffee and Registration**
- 08:50 **Introduction**
Prof. Brett E. Bouma, **CBORT Director**
- 09:00 **Session 1: Advances in Contrast Mechanisms**
Discussion Leader: Maxina Sheft
- 10:00 **Coffee Break**
- 10:20 **Session 2: Fluorescence in Cancer**
Discussion Leader: Giulia Mansutti
- 11:20 **Panel Discussion: Academia and Industry**
Moderator: Yong-Chul Yoon, **CBORT**
- 12:20 **Lunch and Discussion**
- 13:20 **Session 3: Computational Biophotonics**
Discussion Leader: Shreyas Bharadwaj
- 14:50 **Keynote Speaker**
It Goes without Saying: Taking the Guesswork Out of
Your PhD in Engineering by Prof. Caroline Boudoux
- 15:30 **Break and Poster Setup**
- 15:40 **Poster Session**
- 16:55 **Concluding Remarks and Poster Awards**
- 17:15 **Social Hour @ Cambridge Brewing Company**

Session 1: Advances in Contrast Mechanisms

*Discussion Leader: Maxina Sheft
Wellman Center for Photomedicine*

Talk 1: 9:00 – 9:30

Asynchronous, semi-reverberant elastography

Ginger Schmidt, *Wellman Center for Photomedicine*

Optical coherence elastography measures elasticity. Wave-based elastography leverages the properties of shear waves traveling through tissue primarily to infer shear modulus. These methods have seen significant development over the past decade; however, existing implementations in OCT require robust synchronization of shear wave excitation with imaging, complicating widespread clinical adoption. We present a method for complete recovery of the harmonic shear wave field in an asynchronous, conventional frame-rate, raster-scanning OCT system by modeling raster-scanning as an amplitude modulation of the displacement field. This technique recovers the entire spatially and temporally coherent complex-valued shear wave field from just two B-scans, while reducing the time scale for sensitivity to motion from minutes to tens of milliseconds. To the best of our knowledge, this work represents the first successful demonstration of reverberant elastography on a human subject in vivo with a conventional frame-rate, raster-scanning OCT system, greatly expanding opportunity for widespread translation.



Ginger Schmidt is graduate student researcher in the Center for Biomedical OCT Research and Translation (CBORT) within the Wellman Center for Photomedicine. She is studying Medical Engineering & Medical Physics through the Harvard-MIT Health Sciences and Technology (HST) PhD program. She is developing signal processing methods and hardware solutions to enable tissue elasticity measurements in vivo with elastography. Prior to her graduate studies, she studied engineering at Harvey Mudd College.

Session 1: Advances in Contrast Mechanisms

*Discussion Leader: Maxina Sheft
Wellman Center for Photomedicine*

Talk 2: 9:30 – 10:00

Exploring polarimetric imaging for label-free guidance of diagnostic and surgical procedures in oncology

Michael Singh, University of Toronto

Polarimetry is emerging as a promising label-free cancer detection/imaging approach via its sensitivity to micro/macro structural changes during tumor development. Polarimetry currently lacks the specificity to yield diagnoses, however, it can be performed rapidly in a wide field-of-view. Thus it can instead be used to guide more sensitive but slower diagnostic tools to regions of interest thereby shortening their acquisition times. Our recent study employs wide-field polarimetric image guidance to target regions of interest on thick ex-vivo human breast to optimize mass spectrometry analysis. We also explore polarimetric contrast between cancerous and healthy tissue on the resected human breast specimens as well as on live pancreatic adenocarcinoma bearing mice.



Michael is a 5th year PhD student in Dr. Alex Vitkin's laboratory as part of the Applied Biophotonics Division of Medical Biophysics at the University of Toronto. Michael completed his Bachelors degree in physics, and a Masters thesis on femtosecond laser-matter dynamics for molecular imaging and material ablation applications. Michael's PhD studies focus on polarized light scattering dynamics in heterogenous media to advance the science of polarimetry into the biomedical domain. His recent research explores the use of polarimetric imaging as a potential tool to guide (1) mass spectrometric probing for optimized tissue diagnostics and (2) surgical resection of tumors.

Session 2: Fluorescence in Cancer

*Discussion Leader: Giulia Mansutti
Wellman Center for Photomedicine*

Talk 3: 10:20 – 10:50

Pressure Enhanced Sensing of Tissue Oxygen: Guided surgical resection by detection of hypoxic tissue

Arthur Felix Petusseau, Optics in Medicine at Dartmouth Research Center

Fluorescent markers can make surgery more specific by enhancing contrast during tissue resection in certain types of disease. Pressure-Enhanced Sensing of Tissue Oxygenation (PRESTO) uses a commonly available human precursor molecule, 5-Aminolevulinic Acid, to stimulate immediate fluorescence when there is hypoxia present. This pre-contrast agent is metabolized into heme in most human cells, but produces a red fluorescent molecule, protoporphyrin IX, as an intermediate contrast agent. PpIX's delayed fluorescence is amplified in low oxygen environment of tissue.

PRESTO contrast can be used through tissue palpation, leading to contrast greater than 5 in pancreatic, brain, ovarian and head & neck tumors. PRESTO imaging is the first real-time widefield acquisition of palpation response in vivo, making it a valuable tool for highlighting hypoxic tissues and guiding oncologic surgical resection.



Arthur earned his Master's degree in Photonics and Medical Engineering from the University of Strasbourg, France, in 2018, where he collaborated with Prof. Sylvain Gioux on developing digital holography methods for in vivo tissue imaging. He joined Brian Pogue's lab at Dartmouth College in 2019, completing his Ph.D. in early 2023 with a focus on time-domain imaging of tissue metabolism. Currently, Arthur is a postdoctoral researcher in Prof. Bruza's lab at Dartmouth College. His research interests include fluorescence imaging, oximetry, fluorescence-guided surgery, and FLASH radiation therapy.

Session 2: Fluorescence in Cancer

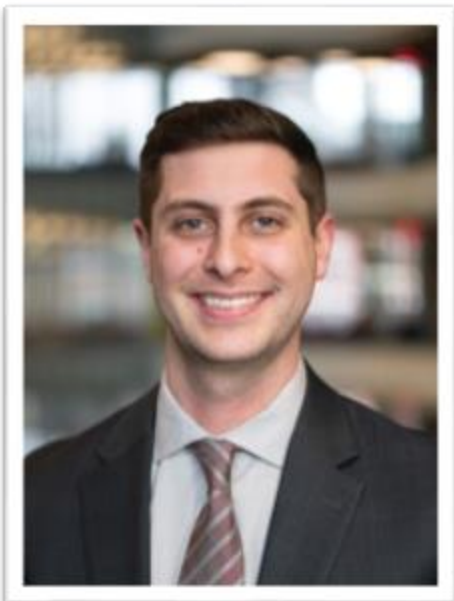
*Discussion Leader: Giulia Mansutti
Wellman Center for Photomedicine*

Talk 4: 10:50 – 11:20

In Vivo Labeling and Detection of Circulating Tumor Cells with Fluorescent Molecular Contrast Agents

Josh Pace, Northeastern University

Circulating tumor cells (CTCs) are the main facilitators of hematogenous metastasis. Our lab has developed a technique called 'diffuse in vivo flow cytometry' (DiFC) to non-invasively optically detect and enumerate CTCs from the tissue surface. Here, we report on combining DiFC with clinical stage fluorescent molecular contrast agents for the labeling and detection of CTCs in mice.



Josh Pace is a fifth-year graduate student pursuing his Ph.D. in Bioengineering with a focus in biomedical optics at Northeastern University. Under the guidance of Mark Niedre, his research is focusing on the fluorescent detection of circulating tumor cells directly in the blood of mice. He received a B.Sc. Degree in Biomedical Engineering from the University of Arizona in 2019.

Academia versus Industry

Panel discussion: 11:20 – 12:20



Dr. Yong-Chul Yoon, Moderator
Wellman Center for Photomedicine

Yong-Chul Yoon recently received his PhD from the Health Science and Technology (HST) at MIT, where he developed a novel optical coherence tomography (OCT) platform for identifying nerves during surgery under the supervision of Benjamin J. Vakoc at the Massachusetts General Hospital. Currently, he is finishing up his research as a post doc in the same lab while co-founding a start-up company that seeks to tackle the extremely difficult challenge of non-invasively inferring glucose concentration in vivo. Outside of research, he enjoys drumming for the Midnight Motion, a Boston-based funk R&B band.



Dr. Nili Persits, Industry Panelist
Dottir Labs

Nili Persits, the founder and CEO of Dottir Labs, has a Ph.D. in electrical engineering from MIT and over 10 years of industry experience of sensor design and integration. Her technology focuses on the scaling of optical spectroscopic Raman sensors to enhance sustainability across multiple industries including chemical manufacturing, food & beverage, agriculture, and environmental monitoring. Nili is a 2023 Activate fellowship recipient and has also received numerous grants and awards supporting women in STEM and entrepreneurship.



Dr. David Veysset, Hybrid Panelist
Wellman Center for Photomedicine

David Veysset earned his PhD in Physical Chemistry from MIT in 2016 before completing postdoctoral training at MIT and Stanford University. In 2022, he co-founded Aluminio, a climate tech start-up, in 2022 and was a Breakthrough Energy Fellow. In 2024, he joined the Wellman Center for Photomedicine at MGH as a Physicist and Instructor. His current research focuses on developing novel optical diagnostics tools, bridging optics, acoustics, and spectroscopy.

Academia versus Industry

Panel discussion: 11:20 – 12:20



Prof. Christa Haase, Academia Panelist
Northeastern University

Christa Haase is an Assistant Professor of Bioengineering and Physics at Northeastern University. Her lab focuses on uncovering how microenvironmental cells impact fate decisions in blood stem cells and drive the development and recurrence of blood cancers, such as leukemia. To achieve this, they design and apply cutting-edge spatial, single-cell, and optical technologies that enable the analysis of microenvironmental cells *in vivo*. Prior to joining Northeastern University, she was an Instructor at the Wellman Center for Photomedicine at Harvard Medical School and worked with the laboratory of Dr. Charles Lin, where she developed Image-seq, a technology that provides single-cell transcriptional and multi-omics data on cells that are isolated from specific spatial locations under image guidance. The technique is compatible with intravital microscopy and makes it possible to integrate the spatial, temporal and molecular information of the target cells. Moreover, it is uniquely suited to study rare cell populations in bone marrow tissue, including hematopoietic stem cells, leukemia initiating cells and stromal cells.



Dr. Sarat Chandra Gundavarapu, Industry Panelist
SiPhox Health

Sarat Gundavarapu is the Director of Photonics and Reader Development at SiPhox Health. He has over 10 years of experience in varied fields of integrated photonics including low-noise lasers, biomedical imaging, and optical sensors. Sarat received his Ph.D. at University of California, Santa Barbara developing silicon nitride integrated photonic Brillouin lasers and was a research fellow at Harvard Medical School and Massachusetts General Hospital, developing portable optical systems for clinical and translational imaging.

Session 3: Computational Biophotonics

*Discussion Leader: Shreyas Bharadwaj
Wellman Center for Photomedicine*

Talk 5: 13:20 – 13:50

Towards streamlining the breast pathology workflow: automated processing of breast optical coherence tomography volumes

Arielle S. Joasil, Columbia University

Breast cancer incidence is increasing yearly in the United States. This increased incidence necessitates the fast and accurate triaging of specimens for pathological examination. If data are acquired quickly, optical coherence tomography (OCT) has the potential to impact breast pathology. Recovering undersampled volumes with compressed sensing (CS) can allow for faster acquisition. In this talk, I will discuss the CS reconstruction of human breast OCT volumes and the diagnostic accuracy of these volumes.



Arielle S. Joasil is a fourth-year PhD candidate in the Electrical Engineering Department at Columbia University. She works with Dr. Christine P. Hendon in the Structure Function Imaging Laboratory, where she applies machine learning and image processing techniques to detect disease in optical coherence tomography volumes of the breast and aid the breast pathology process.

Session 3: Computational Biophotonics

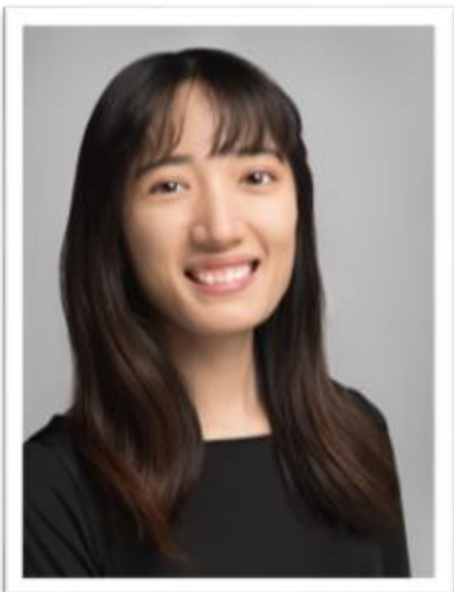
*Discussion Leader: Shreyas Bharadwaj
Wellman Center for Photomedicine*

Talk 6: 13:50 – 14:20

NeuroPath: A Neuropathology-Specific Foundation Model for Advancing AI-Powered Analysis of Neurodegenerative Diseases

Shuying Li, Boston University

Conventional neuropathological evaluations, whether for research or clinical diagnosis, are time-intensive and heavily reliant on expert interpretation, often leading to significant variability in results. This subjectivity underscores the need for more precise and efficient approaches. Here, we introduce NeuroPath, the first foundation model designed specifically for neuropathology. By leveraging digital neuropathology WSI database at the Boston University Alzheimer's Disease Research Center (ADRC), NeuroPath aims to transform the analysis of diseases such as Alzheimer's disease (AD), chronic traumatic encephalopathy (CTE), and other NDs. NeuroPath is developed using DINOv2 self-supervised learning (SSL) techniques and its performance is further evaluated through slide-level neuropathological tasks using attention-based multiple instance learning, including predictions of CTE staging. Our approach offers enhanced accuracy and reliability for analyzing complex neuropathological data and can potentially transform the field of digital neuropathology, facilitating faster, more accurate, and predictive assessments that could revolutionize our understanding and treatment of NDs.



Shuying Li is a Postdoctoral Associate in the Department of Electrical & Computer Engineering at Boston University. She earned her Ph.D. in Biomedical Engineering from Washington University in St. Louis. Her research integrates artificial intelligence (AI) with biophotonics, focusing on leveraging advanced AI tools to enhance optical imaging techniques for improved diagnostic precision and deeper insights into disease mechanisms. In her current role, she applies AI algorithms to human brain images captured by Polarization-Sensitive Optical Coherence Tomography (PS-OCT), Quantitative Birefringence Microscopy (qBRM), and neuropathological slides, striving to unlock new dimensions of neurodegenerative disease understanding.

Session 3: Computational Biophotonics

*Discussion Leader: Shreyas Bharadwaj
Wellman Center for Photomedicine*

Talk 7: 14:20 – 14:50

Developing medical diagnostics with computational biophotonics

Taylor L. Bobrow, Johns Hopkins University

Computational biophotonics combines optical imaging systems and software algorithms to measure quantitative, diagnostic information from imaged tissue.

I will present our research in developing and translating computational biophotonics technologies for a variety of important healthcare needs, including (1) preventing colorectal cancer with a computational colonoscope and deep learning, (2) detecting catheter-associated urinary tract infections with lens-free holographic imaging, and (3) increasing access to eye care in low-resource settings with a low-cost, handheld wavefront aberrometer.



Taylor Bobrow is a Malone Postdoctoral Fellow in the Department of Biomedical Engineering at the Johns Hopkins University. He completed his BS in electrical engineering at Old Dominion University in 2017 and received his PhD in biomedical engineering from the Johns Hopkins School of Medicine in 2024. His current research is focused on using computational imaging to enable low-cost, continuous point-of-care monitoring with applications such as the prevention of hospital-acquired infections.

Keynote speaker

Talk 8: 14:50 – 15:30

It Goes without Saying Taking the Guesswork Out of Your PhD in Engineering

Prof. Caroline Boudoux, Polytechnique Montréal

The definitive toolkit for doctoral students in engineering on thesis—and journal article—preparation, project (and stress) management, IP protection, collaborations, and other aspects of the PhD journey.

It shouldn't take a PhD to get a PhD, but sometimes the process can seem that confusing—even though, to the mentors and advisors, so obvious that it goes without saying. For doctoral students in engineering confronting this dilemma, Caroline Boudoux, an accomplished researcher and entrepreneur, provides a demystifying guide to the challenges—daunting, seemingly routine, and at times unexpected—of pursuing a PhD in this demanding field. In *It Goes without Saying*, Boudoux marshals her considerable experience

mentoring graduate students, teaching doctoral workshops, and—not so long ago—earning her own PhD at MIT to give PhD candidates the know-how, and the confidence, to succeed.



Caroline Boudoux is Professor of Engineering Physics at Polytechnique Montréal and Co-founder and Copresident at Castor Optics, a company commercializing a new line of double-clad fibers couplers. She is on the Board of Meetings for OPTICA, is a Fellow of SPIE, and a Fulbright scholar. Prof. Boudoux obtained her PhD from the Harvard-MIT Health Sciences and Technology program (USA) and completed a post-doctoral fellowship at Ecole Polytechnique (France) before starting her laboratory, in 2007, at Polytechnique Montreal (Canada). Her research topics range from laser-tissue interactions to novel instruments for biomedical imaging.

List of Posters

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3D Surface Dosimetry During Proton Therapy Via Ultra-Fast Imaging and Stereovision Positioning

Roman Vasylytsiv, *Dartmouth College*

P02

Application of Machine Learning to Circulating Tumor Cell Enumeration in Diffuse In Vivo Flow Cytometry

Mehrnoosh Emamifar, *Northeastern University*

P03

Custom Fabrication of 20 FPS Multiphoton Fluorescence Microendoscope for In Vivo Cancer Imaging

Kai Zhang, *Northeastern University*

P04

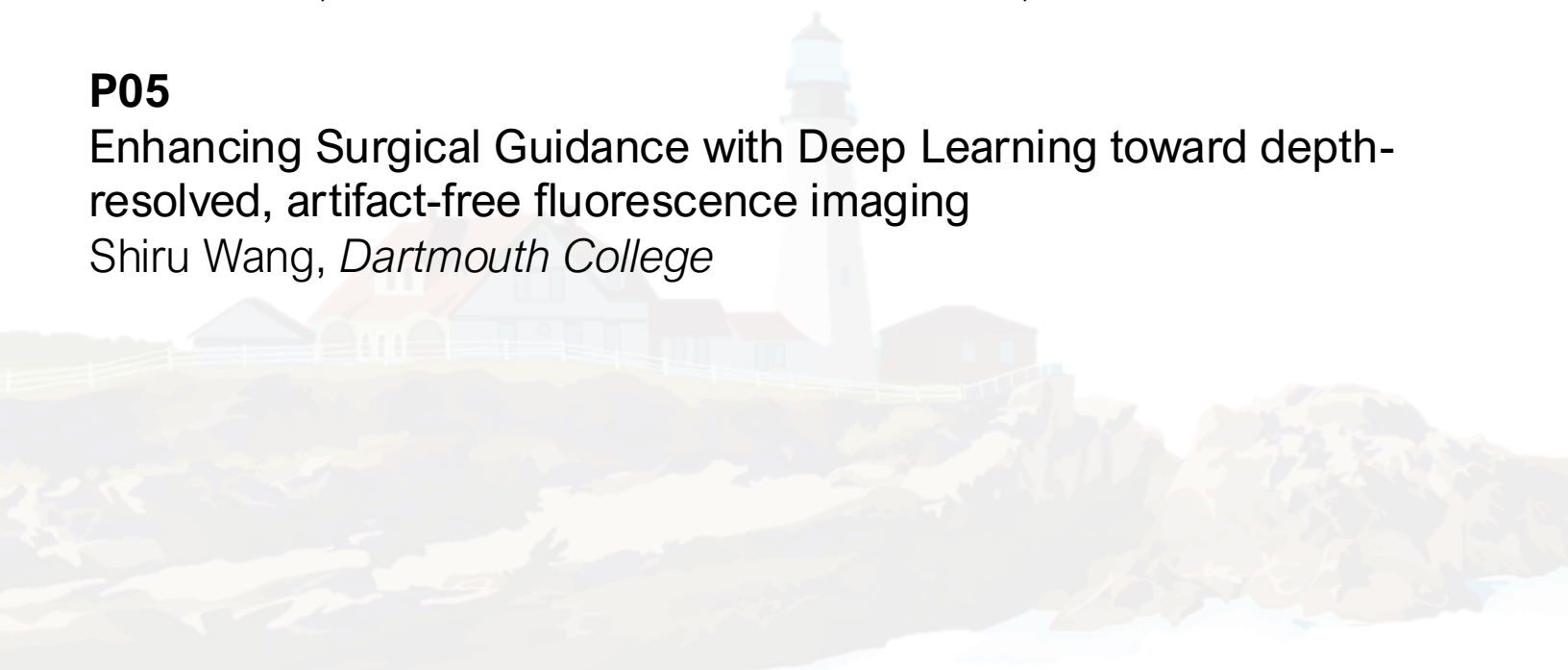
Antibody-Photosensitizer Conjugate for Delineation of Oral Cancer Tumor Margins and Treatment of Residual Disease

Derek Allen, *Wellman Center for Photomedicine, HMS – MGH*

P05

Enhancing Surgical Guidance with Deep Learning toward depth-resolved, artifact-free fluorescence imaging

Shiru Wang, *Dartmouth College*



List of Posters

P06

Exploring polarimetric imaging for label-free guidance of diagnostic and surgical procedures in oncology

Michael D. Singh, *University of Toronto*

P07

First clinical experience of MRSA biofilm detection on bone in infected open fracture with OCT

Natalia Demidova, *Dartmouth-Hitchcock Medical Center*

P08

HiLo Microscopy with Caustic Illumination

Guorong Hu, *Boston University*

P09

Impact of Fixation on Collagen and Elastin Organization in Rat Tissues: A Multiphoton Microscopy Study

Einstein Gnanatheepam, *Tufts University*

P10

Label Free Flow Cytometry of Circulating Tumor Cell Clusters

Taras Hanulia, *Tufts University*

P11

Label-free, two-photon fluorescence imaging reveals dynamic human neuron-glia metabolic cell interactions following injury

Yuhang Fu, *Dartmouth College*

List of Posters

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Label-free, two-photon, non-destructive images reveal lack of metabolic and morphological heterogeneity in cervical precancerous lesions

Nima Najafi Ghalehlou, *Dartmouth College*

P13

Multispectral, Meso-scopic Imaging of Neural and Vascular Dynamics in the Awake Rodent Cortex

Kai Kumeno, *Northeastern University*

P14

Neuroinflammation Exacerbates Declined Astrocyte Ca^{2+} Release During Whisker Stimulation in an Alzheimer's Disease Mouse Model

Chang Liu, *Northeastern University*

P15

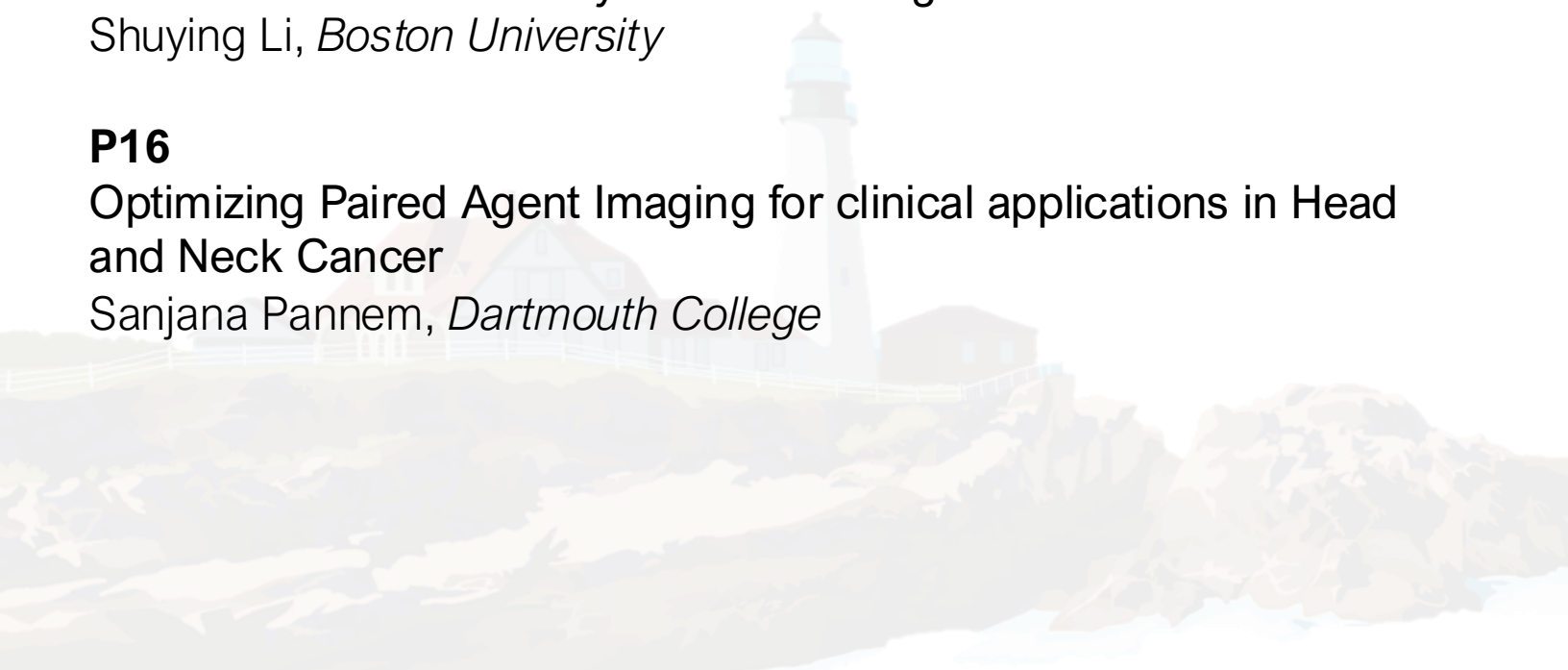
NeuroPath: A Neuropathology-Specific Foundation Model for Advanced AI-Based Analysis of Neurodegenerative Diseases

Shuying Li, *Boston University*

P16

Optimizing Paired Agent Imaging for clinical applications in Head and Neck Cancer

Sanjana Pannem, *Dartmouth College*



List of Posters

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Physiology and Behavior Monitor for Intravital Imaging in Small Mammals

Yuntao Li, *Northeastern University*

P18

Proximal-end Recovery of Multimode Fiber Transmission Matrices

Shreyas Bharadwaj, *Massachusetts Institute of Technology*

P19

Tethered diffuse in vivo flow cytometry for detection of fluorescent circulation tumor cells in awake, freely moving mice

Jane Lee, *Northeastern University*

P20

Towards Organism-Wide All-Optical Physiology in a Vertebrate

Luis Hernandez-Nunez, *Harvard University*





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