Pushing the Limits of Science

In 2018, BU Trustee Rajen Kilachand (Questrom'74, Hon.'14) made a historic gift of $115 million to Boston University, $100 million of which established the Rajen Kilachand Fund for Integrated Life Sciences and Engineering, supporting interdisciplinary research and solutions to some of today's biggest challenges in the life sciences. This year, four BU research teams that include ENG faculty have received Kilachand Fund awards.

Understanding Sleep and Neurodegenerative Disorders

The length and quality of sleep declines across a person's life span. Since sleep plays a critical role in brain health, that decline is linked to neurodegenerative disorders like Alzheimer's disease and Parkinson's disease.

Anna Devor and Laura Lewis, both associate professors of BME, hypothesize that specific blood flow patterns in the brain during sleep are critical for clearing waste and protecting against neurodegeneration.

Their team will test this hypothesis through rodent models, investigating how the brain's blood vessels control clearance during sleep and whether enhancing these vascular patterns can improve brain health.

Metamaterials for Low-Cost, Portable MRI

Magnetic resonance imaging (MRI) is a mainstay among the diagnostic imaging tools available in modern healthcare, but the technology remains limited by the huge size of the superconducting magnets needed for powerful imaging.

Professor Xin Zhang (ME, ECE, BME, MSE), Professor Ioannis Paschalidis (ECE, BME, SE, CDS) and a School of Medicine colleague will develop an ultra-low field (ULF) MRI system with much smaller magnets, crafting a metamaterial-enhanced hardware to physically boost the signal received by the imaging system.

Their proposed ULF-MRI technology would lead to low-cost technology that is readily portable and mobile and could mitigate financial constraints that prevent MRI from being used widely in developing countries.

Dynamic Protein Sequencing

Proteins are the cell's primary molecules for performing biochemical processes. Select proteins within living cells can be studied with fluorescent microscopy. But there are thousands of proteins inside a human cell, making this painstaking technique impractical.

Professor David Boas (BME) and colleagues intend to develop a new technique for targeting and imaging multiple proteins at the same time.

They call their approach PRISM (PRotein Identification by Super-spectral Microscopy), and say it allows for the simultaneous identification, quantification and localization of thousands of different protein molecules inside individual human cells through a "fingerprinting" process using spectral light.

Discovering the Mechanisms of Evolution

All living organisms are under constant selective pressure to evolve new traits. Whether it's a virus or a tumor cell, interactions with the environment shape organisms' genomes to improve their ability to survive and reproduce. However, little is known about the precise molecular mechanisms that underlie the process of adding beneficial mutations into the genome.

Associate Professor Mo Khalil (BME) and colleagues hypothesize that microRNAs (miRNAs), a family of small regulatory RNAs that repress gene expression, allow organisms to explore the evolutionary space efficiently because the effect of these miRNAs is reversible. That's in stark contrast to random genetic mutations, which are affixed.

The project seeks to understand the molecular basis underlying animal evolution using a systematic, unbiased approach that will provide the framework for understanding miRNAs and how they contribute to cancer and chemotherapy resistance in certain tumors. – CHUCK LEDDY

Anna Devor (BME)

Laura Lewis (BME)

Xin Zhang (ME, ECE, BME, MSE)

Ioannis Paschalidis (ECE, BME, SE, CDS)

David Boas (BME)

Mo Khalil (BME)

PHOTOGRAPHY: CYDNEY SCOTT; LEWIS, ZHANG, PASCHALIDIS: SCOTT NOBLES; BOAS: DAN AOUIRRE; KHALIL

NEWS BYTES

THREE ENG FACULTY PROMOTED

Three ENG faculty members have been promoted to the rank of associate professor with tenure. **Manuel Egele (ECE)** specializes in systems security, with an emphasis on software security, web security and security and privacy on mobile systems and online social networks. A recent recipient of ENG's Early Career Research Excellence Award, he leads BU's Secure Systems Lab. His research into malware and the protection of computing platforms is supported by multiple large grants from the National Science Foundation, the Office of Naval Research and Sandia National Laboratories.

Francesco Orabona (ECE, SE, CS) bridges the mathematical foundations of learning theory and data science with applications to scientific, societal and real-world engineering problems. His efforts have led to the development of autonomous online learning algorithms that require minimal human supervision—first-of-its-kind work that is now part of Microsoft's machine learning tool kit. He is the past recipient of a Google Research Award, and a Data Science Faculty Research Fellow at BU's Hariri Institute.

Sahar Sharifzadeh (ECE, MSE) uses first-principles electronic structure methods to understand and predict the electronic, magnetic and structural properties of materials with the goal of designing resilient new materials for computational and semiconductor use. A recipient of the US Department of Energy's Early Career Research Award, she is a member of the American Physical Society and the American Chemical Society.

FIRST RED HAT AWARDEES NAMED

The Rafik B. Hariri Institute for Computing and Computational Science & Engineering: Red Hat Collaboratory has announced the first recipients of the Red Hat Collaboratory Research Incubation Award. Projects funded through this award are open source and focus on problems of distributed, operating, security or network systems whose solutions show promise for advancing their fields and impacting the tech industry.

Nine of the 16 BU professors who received the Red Hat award are ENG faculty members. Professor **Ayse Coskun (ECE)**, Assistant Professor **Alan Liu (ECE, CS)** and Assistant Professor **Gianluca Stringhini (ECE)** and collaborators will build, apply and scale AI frameworks to improve performance, management, security, compliance and resilience problems in the cloud.

Distinguished Professor **Christos Cassandras (ECE, SE)** will take part in a project to create a global, open research platform where researchers can collaborate to define a link between well-being and eco-smart cities.

Professor **Martin Herbordt (ECE)** will collaborate on an open-source tool for reducing application development effort and turnaround time for field programmable gate arrays, and on a generic operating system and firmware for reconfigurable hardware called Dynamic Infrastructure Services Layer.

Associate Professor **Ajay Joshi (ECE)** will work on privacy-preserving cloud computing using homomorphic encryption; Assistant Professor **Renato Mancuso (CS, ECE)** will create a hardware-software codesign paradigm for data systems that implements near-memory processing; Assistant Professor **Eshed Ohn-Bar's (ECE)** project is open-source, multiorganizational collaborative training for societal-scale AI systems; and **David Starobinski's (ECE, SE)** is intelligent data synchronization for hybrid clouds.

LUCE SCHOLARS PRESENT PROJECTS AT UROP SYMPOSIUM

Three ENG winners of the 2021 Clare Boothe Luce Scholar Award presented their research during the 24th Annual Undergraduate Research Symposium, sponsored by BU's Undergraduate Research Opportunities Program (UROP). More than 275 undergrads earned UROP funding and faculty mentoring to complete research projects last summer. Out of those, just six earned the Luce award, three of whom are ENG mechanical engineering students.

Sophie Caplan (ENG'23) worked with **Assistant Professor William Boley (ME, MSE)** to develop a slicer that improves the print path in the 4D-printing process, a newer form of additive manufacturing in which the printed object is programmed to shape-shift over time. Caplan and Boley's slicer system makes it less tedious to design and program such objects.

Kiran Gomatham (ENG'23) worked with **Assistant Professor Tomasso Ranzani (ME, MSE, BME)**. She helped design and optimize the manufacturing process of a major component of a new soft robotic arm for minimally invasive heart surgery. The arm features greater freedom of movement and vertical expansion and contraction for better maneuverability.

Taylor Janke (ENG'22) worked on another soft robotic device with medical applications. Under the guidance of **Assistant Professor Sheila Russo (ME, MSE)**, Janke used a laser cutter and heat press to manufacture an expandable needle deployment mechanism aimed at a safer, simpler and cheaper lung biopsy process.

TWO AWARDS FOR BU SHPE

For the third year in a row, the BU student chapter of the Society of Hispanic Professional Engineers (SHPE) won the Society's Blue Chip Award. And for the first time, the chapter won the SHPE Student Chapter of the Year Award for Region 4, which covers 50 chapters in the Northeast as well as Puerto Rico and Washington, D.C.

The awards recognize the students' work in promoting the professional development of SHPE chapter members and of their contributions to the community. Chapter activities include professional speakers—for example, hosting Hispanic executives from Microsoft and Texas Instruments to share their life journeys and answer career questions—and technical skills workshops, as well as social and cultural events. In addition, the chapter organizes donations and volunteering activities at local nonprofits, such as the Greater Boston Food Bank and Entre Familia, a Boston Public Health Commission program that aids pregnant and postpartum women who have histories of substance abuse.

ALUM WINS TWO PATENTS

Ziad El-Jamous (ENG'08) has been awarded two US patents in the past two years. His invention patented in 2021 is a system for detecting bots on social media. The system distinguishes human users from automated programs by assigning a likelihood score computed from statistical, temporal and text features in a user's profile. In 2020, El-Jamous won a patent for another social media innovation, a system of generating graph structures and text features that can be used for developing and testing new social media analytics or for generating or analyzing social bot network behavior and campaigns in social media, and for sharing test data without raising privacy concerns. ■