



University of Dayton Department of Electro-Optics and Photonics

Spring 2024

Chair's Corner Andrew Sarangan

2023/24 was a spectacular academic year for EOP in many aspects. EOP is currently home to five active NSF grants, three of which are led by Swapnajit Chakravarty, one by Partha Banerjee (as co-PI with Penn State), and one by yours truly. We hosted an NSF REU site (Research Experience for Undergraduates) on Semiconductor Electronics and Photonics in collaboration with the Physics Department. It is worth mentioning that this was the first ever REU site awarded in UD's history. Combined with many other contracts and grants that support our graduate students, the financial and scholarly performance of the department has been nothing short of impressive.



In addition to contracts and grants, the EOP department has also been extending its reach into undergraduate programs. After many years in the works, the undergraduate EOP Minor was officially implemented during Spring 2023. In addition, the EOP department also led the efforts in creating the undergraduate Minor in Semiconductor Manufacturing. We also implemented a 12-month professional MS program in EOP. We are currently working with several partner Universities in India to promote this program. Last but not least, we had a very successful and well-attended EOP research showcase in April 2024, which was co-located with our annual advisory board meeting. You can find details of these stories inside this newsletter.

We have a very active SPIE/Optica student chapter. Several EOP students won travel grants from these societies to present their work at major international conferences. Research excellence makes EOP very unique within UD. My job as chair is to support our faculty and students who bring national and international notoriety through publications, citations, contracts and grants. In that sense, my job has been easy so far, thanks to our excellent faculty.

I look forward to another exciting and productive year!

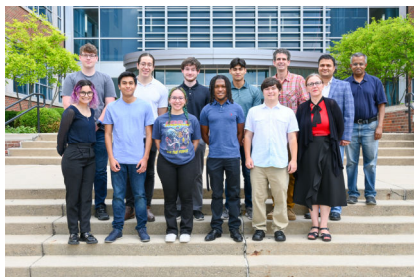
Inside this issue

EOP Highlights.....	2
Conferences	3
Student & Alum News....	4
Publications.....	5
Contracts & Grants.....	5
Recent graduates	6



View from Fitz Hall

NSF REU Site on Semiconductor Electronics and Photonics



UD received its first-ever NSF REU site award in April 2023. Originally led by Jay Mathews of Physics, the grant was transitioned to Swapnajt Chakravarty after Jay's departure from UD. With a total value of \$353k, the project will support research for about 24 undergraduate students over its three year project period.

The 2023 cohort came from St. Mary's University (Texas), University of Texas—El Paso, Morehouse College (Maryland), Youngstown State University (Ohio) and UD. The students lived on-campus, went on field trips and spent 10 weeks with faculty mentors in their laboratories, working on topics such as semiconductor nanocrystals, 2D materials, microfluidics and thin films. The 2024 cohort of students will be arriving on campus in late May.

EOP faculty are internationally recognized experts in their respective fields

Intel-Funded OASIS

Ohio-Southwest Alliance on Semiconductors and IC Manufacturing at Scale (OASIS) was created in 2022 in response to the CHIPS and Sciences Act. UD is a partner in this UC-led effort. EOP and ECE faculty developed several training modules for this program, on various topics ranging from Cleanroom and Safety Protocols to IC Fabrication Process-flow and Metrology. EOP is conducting the hands-on training portion in our cleanroom. Anyone can register for this free certificate program using the QR code.



Atmospheric turbulence during solar eclipse



Mikhail Vorontsov, director of Intelligent Optics Lab, used his unique 7 kilometer atmospheric test range to measure the change in turbulence strength during the total solar eclipse on April 8. This test bed runs from Fitz Hall to the VA hospital in downtown Dayton. His team of researchers observed unexpected atmospheric effects during the 3 minutes of solar darkness. Because of the short duration, a sensing technique with a high measurement rate is required to capture the salient details. A novel AI-based sensor, TurbNet, for real-time atmospheric turbulence strength measurements was developed recently by his team at the UD EOP Intelligent Optics Laboratory and Optonica LLC (a small business in the Dayton area). This sensor allowed the researchers to take readings 30 times faster than with commercially available instruments. They expect to publish their findings in the near future.



MoU's with Indian Universities



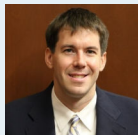
EOP has signed two MoU's with Indian Institute of Technology—Patna (IIT-P) and Shoolini University. Two more MoU's are underway with Gautam Buddha University (GBU) and Vellore Institute of Technology (VIT). These MoU's were designed to promote our newly introduced 12-month professional MS degree program. These partnerships with India grew out of a course that Partha offered at IIT-P on "Digital and Dynamic Holography with Applications" in December 2022, hosted by the Government of India's Global Initiatives of Academic Networks (GIAN), which was followed by a commemorative issue in the Asian Journal of Physics in his honor. During Spring 2024, Partha and Andrew taught a class for GBU to promote this collaboration.

Two new Physics faculty in Photonics

The physics department welcomed two new faculty members in photonics. In addition to Jason Deibel (chair, Physics) and Imad Agha (Assoc Prof, Physics) who are also in optics, Victor Kulikov and Robert Wilson started in Fall 2023. Victor's research is in laser beam propagation through atmosphere and wave-optics simulations. Robert's research is in the area of light transport in biological tissue for diagnostic applications.



Victor Kulikov



Robert Wilson

A Minor in Semiconductor Manufacturing

EOP faculty led the creation of the undergraduate Minor in Semiconductor Manufacturing in collaboration with the ECE and Physics departments. This is the first major reach of EOP in the undergraduate area. We introduced three new courses, EOP/ECE 404 (Semiconductor Characterization and Metrology), EOP/ECE 405 (Semiconductor Device Fabrication Lab) and EOP/ECE 406 (Advanced Semiconductor Manufacturing). This Minor was created to address the growing need for trained engineers in semiconductor manufacturing. EOP also received an NSF-MRI grant for a laser beam lithography (LBL) tool for \$390k in August 2023 which would play a crucial role in this Minor.



EOP's semiconductor cleanroom in the Science Center

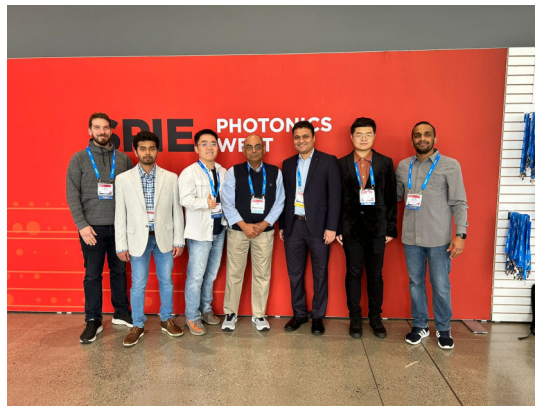


Swapnajit Chakravarty, Daniel Donnelly, Jianhao Shen, Andy Reinhardt (EOP Alum), Eddie Ruff (EOP Alum), Paul McMamamon, Amal Miranda, Remona Heenkenda, Andrew Sarangan, Anna Hecht. SPIE DCS in Orlando, FL. May 2023.



Mohammed Al-Ghezi, Miranda van Iersel, Partha Banerjee, Guo Chen, Angelica Drees, Yujie Yang, Roseanna Lawandi, Prathan Buranasiri (EOP Alum) at SPIE Optics and Photonics in San Diego, CA. August 2023.

Dylan Morden, Asela Perera, Xuesong Gao, Partha Banerjee, Swapnajit Chakravarty, Jianhao Shen, Chaminda Ranatunga at SPIE Photonics West, San Francisco, CA. January 2024.



UD students and faculty at the National Taipei University of Technology as part of the NSF-funded US-Taiwan Advanced Studies Institute for Science, Technology, and Manufacture of Future Display Devices and Systems. August 2023. (Anthony Rapp, Partha Banerjee, Angelica Drees, Matt Howard, Alex Skender)

International Conferences

All EOP students are highly encouraged to present at major SPIE, Optica and IEEE conferences. In 2023/24, several students received travel awards worth over \$3400. Hearty congratulations to the following students:

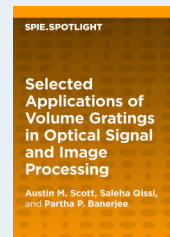
- Jianhao Shen - SPIE Defense and Commercial Symposium (Orlando): \$700
- Danny Donnelly - SPIE Defense and Commercial Symposium (Orlando): \$346
- Guo Chen - SPIE Optics and Photonics Conference (San Diego): \$770
- Baquer Al Ghezi - SPIE Optics and Photonics Conference (San Diego): \$445.
- Roseanna Lawandi - SPIE Optics and Photonics Conference (San Diego): \$1145.

Following are some key conferences that EOP participates in:

- Optica FIO (September)
- IEEE IPC (November)
- SPIE Photonics West (January)
- SPIE Advanced Lithography (February)
- SPIE DCS (April)
- Optica/IEEE CLEO (May)
- Optica OIC (May)
- SPIE Optics and Photonics (August)
- Optica Digital Holography (August)

Spotlight on Austin Scott

Austin graduated with a PhD in December 2023. One of his publications was invited to be a monograph in the SPIE Spotlight Series. This 63 page book, highlighting his research along with contributions from Saleha Qissi, contains applications of volume gratings in beam steering, two-dimensional image processing and 3D multispectral volume digital holography. This book should serve as an important reference to anyone interested in holography and 3D imaging.



EOP Graduate Student Research Showcase



EOP graduate students presented their research during this showcase event held on April 19 2024, which was co-located with the EOP advisory board meeting. The advisory board members present at the meeting include John Taranto (Thorlabs), Akhlesh Lakhtakia (Penn State) and Chris Brewer (AFRL).

Student Awards

- ◆ Daniel Donnelly (ECE undergraduate student) received \$2000 towards his Honors thesis research with Swapnajit Chakravarty.
- ◆ Ming Wei won the Graduate Academic Affairs Award of \$300 for his MS thesis research on Lidar.

Alum Profile: Joshua Borrow

Dr. Joshua Borrow, a native of Baltimore, MD, came to UD with a BS in Physics from Morehouse College in Atlanta, GA. He did his MS and PhD in EOP in 2017 and 2022, respectively. His dissertation was titled “Nanopatterning chalcogenide phase change materials for reconfigurable photonic devices”. During his time as a PhD student, he served as the Optica/SPIE student chapter president where he organized the joint student-lead IONS Midwest Conference in 2018 with Purdue University. As UD’s first Ford Foundation fellowship recipient, he co-authored over 10 papers on chalcogenide phase change materials in collaboration with his mentors at UD, the Air Force Research Laboratory (AFRL) and Stanford University. Additionally, he served as an Executive Board member to the National Society of Black Physicists (NSBP) 2019 – 2021. Upon graduation from UD, he was selected as the 2021 Hibbitt Postdoctoral Fellow in the School of Engineering at Brown University.

“The EOP department not only provided the



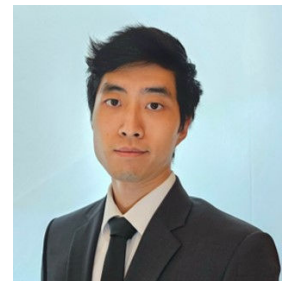
research, professional and financial support to advance my career, but also a broad and in-depth foundation in Optics. I also curated lasting friendships with colleagues who are now spread around the globe doing amazing and impactful work in photonics” he said. “Gaining experience in nanofabrication techniques and characterization methods has elevated my ability to comprehend and effectively contribute to the optics community at large.”

Student Profile: Ming Wei

Ming Wei grew up in Appleton, WI and graduated with honors from the University of Wisconsin - Platteville, earning a Bachelor of Science degree in Engineering Physics. With a keen interest in the interdisciplinary field of engineering and physics, his undergraduate studies provided an excellent foundation for his research at the University of Dayton.

Under the mentorship of Paul McManamon, Ming’s research is in the field of LiDAR (Light Detection and Ranging), a remote sensing technology that uses laser pulses to measure distances. LiDAR has widespread applications ranging from autonomous vehicles, mapping, and security. Ming is particularly intrigued by its potential to revolutionize various industries through advancements in data acquisition, processing algorithms, and hardware optimization. After graduation with his MS degree, he will be working for Paul’s company, Exciting Technology, LLC.

Outside his studies, Ming enjoys staying active and engaged in leisure activities. A passionate tennis player, Ming finds joy and relaxation on the court. Additionally, he indulges in the immersive world of video games, appreciating the interactive storytelling and excitement that defines



SPIE/Optica Student Chapter

The joint student chapter of SPIE and Optica hosts a number of activities throughout the year, from picnics and hikes to technical seminars and outreach activities. In Oct 2023, they invited a Toastmaster’s club representative to discuss the possibility of starting a UD club. In April 2024, a number of students from the chapter visited Silfex (a division of Lam Research Corp) and got a tour of their silicon crystal manufacturing and micromachining. Silfex makes silicon parts for Lam, who makes plasma etch chambers that are used in the manufacture of NAND flash memories.



Publications

This is a partial list of recent journal publications (excludes conference proceedings). For a complete list, please visit each faculty's Google Scholar site.

- **Noof A. Alanazi, Austin M. Scott, Hammid Al-Ghezzi, Muhammad Faryad, Akhlesh Lakhtakia, and Partha P. Banerjee**, "Transport of intensity and phase: applications to digital holography [Invited]", *Applied Optics*, vol. 63, issue 10, pp. 2436-2454 (2024).
- **Austin M. Scott and Partha P. Banerjee**, "Analysis and implementation of volume reflection gratings in photorefractive lithium niobate for edge enhancement", *Applied Optics*, vol. 63, issue 10, pp. 2415-2428 (2024).
- **Partha P. Banerjee, Hammid Al-Ghezzi, Guo Chen, Jonathan Slagle, Mariacristina Rumi, Rudra Gnawali, and Dean R. Evans**, "Prediction of metallo-dielectric transmission filter performance based on underlying dispersion relations", *Journal of the Optical Society of America B*, vol. 41, issue 3, pp. 698-711 (2024).
- **Noof Alanazi, Partha P. Banerjee**, "Retrieval of phase and three-dimensional topography using modified transport of intensity and phase equations with electrically programmable optical path lengths", *Optical Engineering*, vol. 62, issue 11, 113102 (2023).
- **Saleha Qissi and Partha P. Banerjee**, "Multiplexed digital volume reflection holograms generated from digital transmission holograms", *Applied Optics*, vol. 62, issue 10, pp. D171-D180 (2023).
- **Amelia Carpenter, Joel Murray, Lauren M Loftus, Alán Martinez, Robert Turner, Partha Banerjee, and Shekhar Guha**, "Nonlinear optical properties and carrier recombination lifetime of GaN", *Applied Optics*, vol. 62, issue 5, pp. 1152-1159 (2023).
- **Jianhao Shen, Daniel Donnelly, and Swapnajit Chakravarty**, "Slow-wave-enhanced on-chip Michelson interferometer sensor", *Optics Letters*, vol. 48, issue 22, pp. 5968-5971 (2023).
- **Roseanna G. Lawandi, Dylan Morden, Imad Agha, Shivashankar Vangala, and Andrew M. Sarangan**, "VO₂ wire grid polarizers for MWIR applications", *Journal of the Optical Society of America B*, vol. 41, issue 3, pp. 744-749 (2024).
- **Roseanna G. Lawandi, Zhanibek Bolatbek, Imad Agha, Keigo Hirakawa, and Andrew M. Sarangan**, "Continuously variable Fourier filters fabricated using varying angle glancing angle deposition for chip-scale spectroscopy", *Applied Optics*, vol. 63, issue 6, pp. 1517-1521 (2024).
- **Roseanna G Lawandi, Trent Malone, Joshua A Burrow, Joshua R Hendrickson, Shivashankar Vangala, Andrew Sarangan, Imad Agha**, "Fabrication, characterization and numerical modeling of Sb₂Se₃ nano-patterned structures", *Optical Materials Express*, vol. 13, issue 12, pp. 3428-3437 (2023).
- **Joshua A. Burrow, Roseanna G. Lawandi, Andrew Sarangan, and Imad Agha**, "Electrically addressable tungsten doped phase change device in a through pixel configuration", *Optical Materials Express*, vol. 13, issue 4, pp. 1131-1139, (2023).
- **Md Shah Alam, Rudra Gnawali, Joshua R Hendrickson, Diane Beamer, Tamara E Payne, Andrew Volk, Imad Agha**, "Photonic Integrated Circuit for Rapidly Tunable Orbital Angular Momentum Generation Using Sb₂Se₃ Ultra-Low-Loss Phase Change Material", *Advanced Optical Materials*, vol. 10, issue 20, pp. 2200098 (2024).
- **Jordan Adams, Imad Agha and Andy Chong**, "Spatiotemporal optical vortex reconnections of multi-vortices", *Scientific Reports* volume 14, Article number: 5483 (2024).
- **Md Shah Alam, Ryan Laing, Zhanibek Bolatbek, Remona Heenkenda, Rudra Gnawali, Tamara E. Payne, Andrew Sarangan, Joshua R. Hendrickson, Imad Agha**, "Fast Cycling Speed with Multimillion Cycling Endurance of Ultra-Low Loss Phase Change Material (Sb₂Se₃) by Engineered Laser Pulse Irradiation", *Advanced Functional Materials*, 2310306, (2024).

Contracts and Grants

This is a list of EOP-led grants that were active during calendar year 2023.

- Partha Banerjee, Quantum Screening, "Development of Portable Compact Fiber Sensor Monitor For Detection and Quantification of Biomolecules in Body Fluids", **\$105,835**, 09/21/21—06/30/23
- Partha Banerjee, GMU/DHS, "Digital Holographic Acquisition, Storage, Retrieval and Analysis of Three-Dimensional Fingermarks Developed with the Nanoscale Columnar-Thin-Film", **\$300,000**, 04/01/22—06/30/24
- Partha Banerjee, Azimuth/AFRL, "ANN-Aided Design Of Smart Optical Filters and Image Processors Using Novel Photorefractive Materials and Metastructures", **\$21,999**, 07/31/22—07/30/27
- Partha Banerjee, DAGSI/AFRL, "Development of SWIR Avalanche Photodiodes", **\$42,735**, 08/16/23—04/30/24
- Partha Banerjee, PSU/NSF, "US-Taiwan ASIs for Science, Technology and Manufacture", **\$11,719**, 03/01/22—04/29/24
- Swapnajit Chakravarty, NSF, "REU Site: Semiconductor Electronics and Photonics at University of Dayton", **\$353,378**, 04/01/23—03/31/26
- Swapnajit Chakravarty, NSF, "Collaborative Research: PIC: Slow Wave Enhanced Electrooptically Tuned Michelson Interferometer Biosensor for On-Chip Dual Polarization Interferometry", **\$338,076**, 09/01/22—08/31/2025
- Swapnajit Chakravarty, NSF, "PIC: Charge Trapped Photonic Devices for Computing, Sensing and Sequencing Applications", **\$540,000**, 09/01/23—08/31/2026
- Paul McManamon, OSU/OFRN, "Development of High Data Rate Modulator Technology", **\$325,094**, 10/29/21—12/31/23
- Paul McManamon, Azimuth/AFRL, "Characterization of electro-optic crystals for high-speed modulators", **\$54,999**, 06/01/23—06/30/24
- Ernst Polnau, Optonica/DoD "Deep Machine Learning-Enhanced Target-in-the-Loop Adaptive Optics Control for Directed Energy Applications", **\$119,973**, 06/30/22—06/30/23
- Ernst Polnau, Optonica/DoD, "Integrated Sensing Module for In-Situ Atmospheric Path Characterization", **\$70,000**, 04/03/23—10/03/23
- Andrew Sarangan, Azimuth/AFRL, "Tunable Structured Optical Materials", **\$55,000**, 07/31/22—07/30/27
- Andrew Sarangan, DAGSI/AFRL, "Growth and Evaluation of Laser and Nonlinear Optical Materials", **\$151,614**, 08/15/21—10/31/24
- Andrew Sarangan, NSF, "MRI: Acquisition of a laser direct-write photolithography system", **\$390,390**, 09/01/23—08/31/26
- Andrew Sarangan, OSU/OFRN, "ALTITUDE: Affordable Lidar Technologies for Integration and Unmanned Deployment", **\$267,035**, 12/14/21—06/30/23
- Andrew Sarangan, DEC/AFRL, "Low-Cost, Long-Range Lidar", **\$267,035**, 07/01/23—06/30/24
- Miranda van Iersel, Dakota Ridge/Navy, "Images of LWIR wakes", **\$102,000**, 09/01/22—09/01/24
- Miranda van Iersel, AFOSR, "Turbulence profiles of laser beams propagating over slant paths", **\$108,325**, 09/15/23—09/14/26
- Mikhail Vorontsov, NMSU/Navy, "Characterization of atmospheric turbulence in the lower atmosphere", **\$899,928**, 09/01/17—06/30/23
- Mikhail Vorontsov, USAF/J-DETO, "Soaring Otter Subtask", **\$300,302**, 11/10/21—02/12/27
- Thomas Weyrauch, Optonica/USAF, "Advanced Adaptive Optics Based on Scintillation-Resistant, High Bandwidth Multi-Aperture Phase Contract (MAPCO) Sensor and AI/ML Enhanced Controller", **\$75,976**, 09/30/22—02/29/24
- Thomas Weyrauch, Optonica/DoD, "Gimbal-integrated phased array transceiver (GIPAT)", **\$144,038**, 02/07/24—12/06/24

About the EOP Department

The Electro-Optics and Photonics (EOP) department is one of only a handful of academic programs in the U.S that offers M.S and PhD degrees in photonics. All of our faculty are internationally recognized experts in their respective fields, with a significant publication, citations and funding record. Our students publish in leading academic journals, and present at major international conferences. Our research areas directly align with those of commercial industries and government labs, enabling students to obtain hands-on real-world and highly marketable experiences.

Recent Graduates

- **Guerra Vazquez, Jose Cesar**, "Generation of Hyperentangled N00N States with Radial and Orbital Angular Momentum Laguerre-Gauss Modes and Detection-Basis Control", **PhD**, December 2022
- **Szymanski, Maureen**, "Optimizing Performance of Coherent Lidar Systems Using Photon-Counting Arrays", **PhD**, Dec 2022
- **Carpenter, Amelia**, "Measurements of Nonlinear Optical and Damage Properties of Selected Contemporary Semiconductor Materials", **PhD**, May 2023
- **Hilton, Brandon J.**, "Study of Light Emission from GeSbTe Phase-Change Materials Due to Doping", **MS**, December 2022
- **Shen, Jianhao**, "Compact Energy Efficient 1-D Photonic Crystal Cavity Electro-Optical Switch", **MS**, December 2022
- **Smith, Eric G.**, "Optical Image Processing of 2-D and 3-D Objects Using Digital Holography", **MS**, December 2022
- **Vantilburg, Ethan**, "Piezo-Electric Ringing in Deuterated Potassium Dihydrogen Phosphate Electrooptic Crystals", **MS**, December 2022
- **Gregory, Vijay Amir**, "Room Temperature Photoluminescence of Intrinsic and Doped Bulk Germanium using Additional Excitation Source", **MS**, May 2023
- **Ji, Jiajie**, "Object Detection and Classification Based on Point Separation Distance Features of Point Cloud Data", **MS**, May 2023
- **Wu, Hao Lun**, "Experimental Study on the Effects of OAM Beams Propagating through Atmospheric Turbulence", **MS**, May 2023
- **Roseanna Lawandi**, "Tunable Filters for Novel Optical Components", **PhD**, Dec 2023
- **Mohammad Al Baqer Al Ghezi**, "Forecasting the Scintillation Index Using Neural Networks", **MS**, Dec 2023
- **Michael Mueller**, "Investigation of Transient Brillouin Scattering in Optical Fibers Under Pulsed Beam Excitation", **MS**, Dec 2023
- **Nouf Ali Alanazi**, "Phase Retrieval and 3d Topography Using Transport of Intensity", **PhD**, Dec 2023
- **Austin Scott**, "Volume Reflection Gratings in Photorefractive Materials", **PhD**, Dec 2023



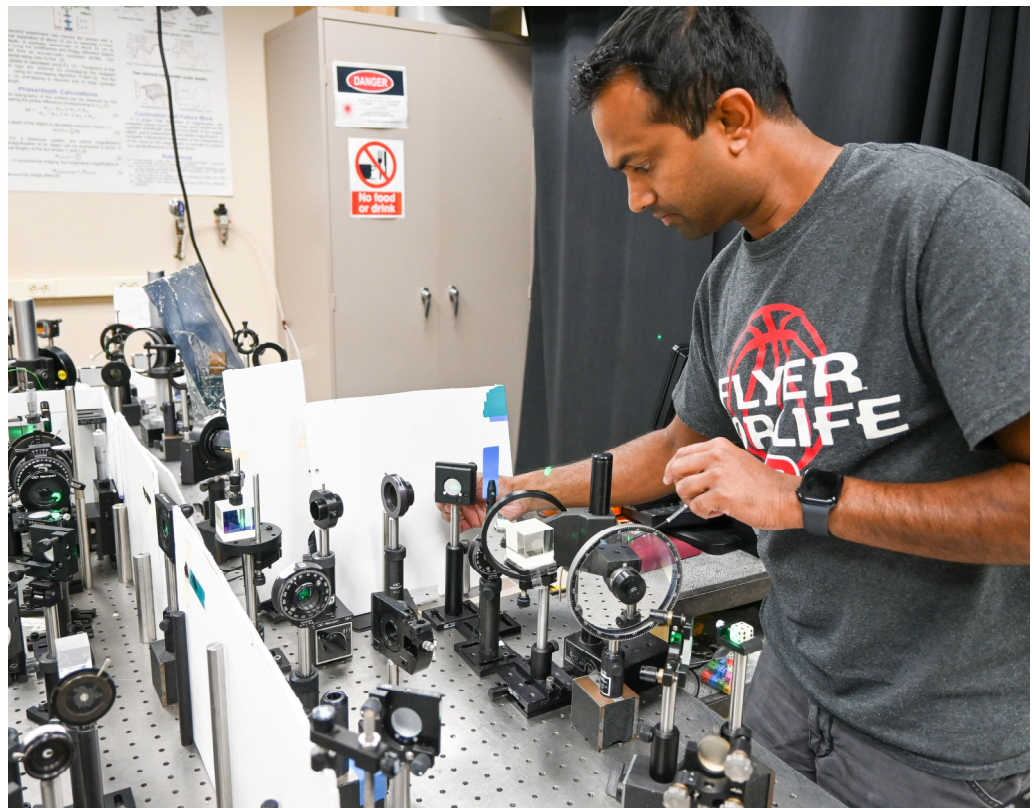
University of Dayton

Department of
Electro-Optics and
Photonics

EOP Department

University of Dayton
300 College Park Ave
Dayton, OH 45469

Phone: 937-229-3190
E-mail: sarangan@udayton.edu



Graduate student Amal Mirando working in the Holography and Metamaterials (HaM) Lab