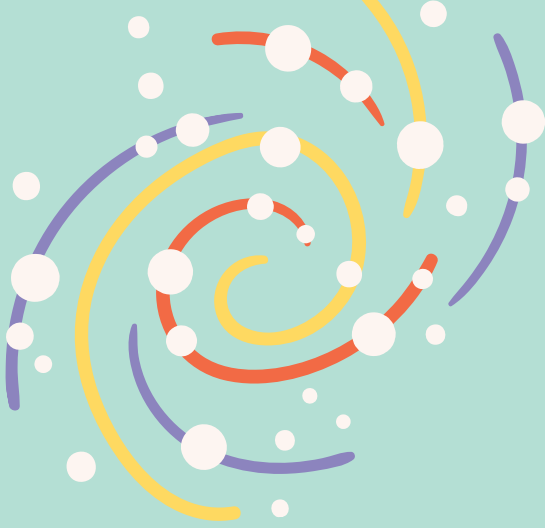
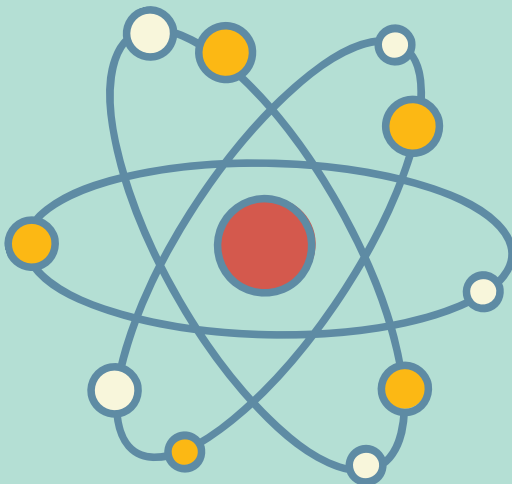


NLST

**SUMMER UNDERGRADUATE
RESEARCH FELLOWSHIP**
SURF 2026





Greetings,

On behalf of the Director's Office, I proudly present the 2026 SURF Colloquium book. The 2026 SURF Program featured 175 participants, all working in person at a NIST campus in Gaithersburg, MD, or Boulder, CO.

Founded by scientists in the Physics Laboratory (PL) with a passion for STEM outreach, the SURF Program has grown immensely since its establishment in 1993. SURF's first cohort consisted of twenty participants from 8 universities who conducted hands-on research primarily in the physics lab. The 2026 cohort, representing all STEM disciplines, included 157 Gaithersburg participants and 18 Boulder participants, collectively from over 80 universities. Participants from both campuses engaged in activities collectively, including the Colloquium.

As you peruse the Colloquium book, you are bound to find topics that pique your interest. You are welcome to email the NIST research advisors about your questions and comments regarding the ongoing research in a specific NIST laboratory. Most staff and scientists are excited to exchange findings and new ideas and love to talk about their roles and research at NIST.

I could not conclude this letter without mentioning the people and who make the SURF Program possible. Thank you to NIST Leadership, the International & Academic Affairs Office (IAAO), Laboratory SURF Leads, SURF mentors, administrative staff, the Badging Office, OISM, AV and Conference Services, and all the staff who play an integral role in creating valuable experiences for the SURF participants. Also, a huge thank you goes out to the participants, their families and friends, and the ambassadors who spread the word about SURF. Your hard work and support are greatly appreciated. Together, we are building the STEM workforce of the future.

I hope you enjoy the 2026 Colloquium and learn something new about the nation's standards laboratory.

Best regards,

A handwritten signature in black ink that reads "Cara O'Malley". The script is fluid and cursive.

Cara O'Malley

NIST SURF Program Director

International & Academic Affairs Office (IAAO)

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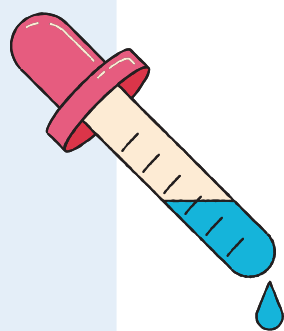
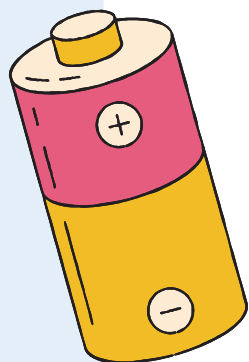
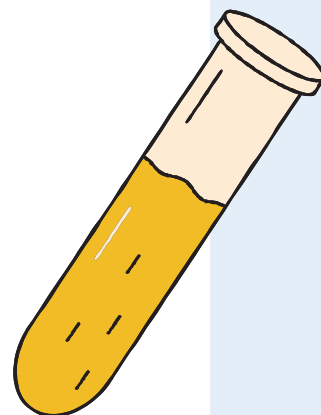
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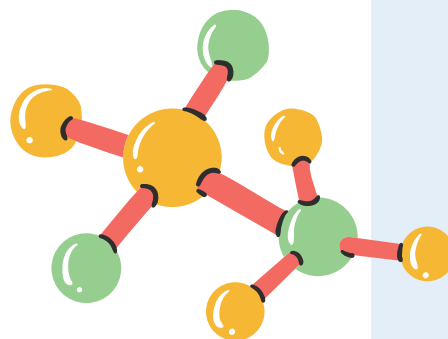
SURF Colloquium N1ST Plenary Session - August 3, 2026		Zoom link: https://nist.zoomgov.com/j/1611193419?pwd=jLFrLapFjtxcN45raSdm3NlTnmwJxJ.1		
Gaithersburg Green Auditorium & Boulder Bldg 1, Room 1107		Meeting ID: 1611193419		Passcode: 325093
11:00 AM MT	1:00 PM ET	Welcome Remarks & Gaithersburg Moderator: <i>Cara O'Malley</i>		Boulder Moderator: <i>Susan Schima</i> Zoom Moderator:
TIME (MT)	TIME (ET)	<i>Plenary Speaker</i> - OU (campus)	Presentation Title	
11:05 AM	1:05 PM	<i>Gabriel Rosen-Turits</i> - CTL (Boulder)	Radiation in Coplanar Waveguides at High Frequencies	
11:30 AM	1:30 PM	<i>Juliana Escuti</i> - ITL (Gaithersburg)	Continuous Validation of BF Specifications of Input/Output Check Related CWEs	
11:55 AM	1:55 PM	<i>Dinah-Luba Beylison</i> - EL (Gaithersburg)	Using Machine Learning to Enable Continuous Uncertainty Quantification of a Digital Twin for an Industrial Robot	
12:20 PM	2:20 PM	<i>Vivia Nguyen</i> - MML (Gaithersburg)	How Many is Too Many: Drug Sensitivity Drifting in Long Passaging HG009 Clonal Cell Lines	
12:45 PM	2:45 PM	BREAK	N/A	
1:00 PM	3:00 PM	<i>Miles Antaya</i> - PML (Gaithersburg)	Bond Strength Measurements of Semiconductor Wafers	
1:25 PM	3:25 PM	<i>Reece Tippery</i> - NCNR (Gaithersburg)	Evaluation of Droplet Breakup and Mixing in a Millifluidic Droplet Generator	
1:50 PM	3:50 PM	<i>Adriano Cristaldi</i> - PML (Boulder)	Optimizing Novel Imaging Protocols to Study Microwave Propagation in the Human Body	
2:15 PM	4:15 PM	END OF PLENARY SESSION	N/A	

		Parallel Session #1	Parallel Session #2	Parallel Session #3
Parallel Sessions Tuesday, Aug 4, 2026	Location	Gaithersburg, Bldg 101, Heritage Room	Gaithersburg, Bldg 101, Portrait Room	Gaithersburg, Bldg 101, Lecture Room D
	Zoom Link	https://nist.zoomgov.com/j/1619541627?pwd=tPz5aBzJx2M7i9vrphwLjHJK5gVaXS.1 Meeting ID: 1619541627 Passcode: 212437	https://nist.zoomgov.com/j/1615780237?pwd=92arHgOoJqT02Yst9izLbOPtdAPOMT.1 Meeting ID: 1615780237 Passcode: 121275	https://nist.zoomgov.com/j/1616477556?pwd=Z2M6Ywv9dRh2xaYzBldZk8Tf8eqAuk.1 Meeting ID: 1616477556 Passcode: 222229
		Host Laboratory: PML	Host Laboratory: EL	Host Laboratory: MML
Time (ET)	Host Info	Moderator: <i>Josh Pomeroy</i> Zoom Moderator: <i>Christina Hacker</i>	Moderator: <i>Patrick Dixon</i> Zoom Moderator: <i>Cartier Murrill</i>	Moderator: <i>Dilara Meli</i> Zoom Moderator: <i>Dan Siderius</i>
	9:00 AM	<i>Myriam Bajani</i> - Cryogenic LC Resonators for RF Reflectometry and Sub-pF Capacitance Measurements	<i>Ambika Anand (CHIPS)</i> - Characterization of Underfills for Reliable Semiconductors	<i>Bridgette Bidwell (CHIPS)</i> - A Density Functional Theory and Machine Learning Workflow for Point Defects in Semiconductors
	9:15 AM	<i>Tenaya Chen Lin</i> - Developing an Interferometric Method for Dose Distribution Measurement in FLASH Radiotherapy Using Inverse Abel Reconstruction	<i>Natalia Quesada Marshall</i> - Spectral Fingerprinting of Pyrrhotite Reactions in Concrete	<i>Aditi Gali (CHIPS)</i> - Additive-Assisted Electrochemical Deposition for Efficient Indium Recovery from Electronic Waste
	9:30 AM	<i>Blayne Fuller (CHIPS) (Recorded presentation)</i> - Automated and Scalable Fast Id-Vg Measurements for SiC Transistor Reliability Characterization	<i>Evelyn Cabrera Hernandez</i> - Mitigating Pyrrhotite-Induced Concrete Damage Through the Application of Sealants and Coatings	<i>Ryan Giang (CHIPS)</i> - Selective Recovery of Indium from E-Waste via Organic Mixed Conductors
	9:45 AM	<i>Eugene Im</i> - Position Correlation of Biphotons Using Gated Single Photon Imaging Method	<i>Illai Faiman</i> - Mapping Pyrrhotite-Driven Internal Aulfate Attack in Concrete Foundations with XRF	<i>Logan Magaha (CHIPS)</i> - CD-SAXS Code Advancements and Round Robin for Development of a New Calibration Standard
	10:00 AM	<i>Lavanya Mahajan (CHIPS)</i> - Defect Characterization of SiC MOSFETs Using Electrical Measurements and EDMR	<i>Alexander Ibacache</i> - Expansion and Degradation of Two-Dimensional Configurations of Fused Quartz and Cement	<i>Janet Park (CHIPS)</i> - Optimizing High-Resolution DLP-SLA 3D Printing for Microfluidic Prototyping
	10:15 AM	BREAK	BREAK	BREAK
Time (ET)	Host Info	Host Laboratory: PML Moderator: <i>Daniel Jardin</i> Zoom Moderator: <i>Christina Hacker</i>	Host Laboratory: EL Moderator: <i>Cartier Murrill</i> Zoom Moderator: <i>Katherine Hoffman</i>	Host Laboratory: MML Moderator: <i>Yvonne Gerbiq</i> Zoom Moderator: <i>Trina Mouchahoir</i>
	10:30 AM	<i>Juandiego Astudillo</i> - Progress Developing Frequency-Multiplexed Data Acquisition for Charged Particle Thermal Kinetic Inductance Detector	<i>Evan Taller</i> - Investigating Corrosion Properties of Steel Reinforcements in Concrete Made With Alternative Cement Formulations	<i>Christopher Gutowski (CHIPS)</i> - Characterizing HfO2 and TiN-Gold thin-films using Ellipsometry and X-ray Reflectivity
	10:45 AM	<i>Matthew Bertagna</i> - Pulse Processing of Initial Charged Particle Data from Prototype Thermal Kinetic	<i>Jessica Wang</i> - Photodegradation Mechanism Study of Polypropylene (PP)	<i>Salihcan Kremer (CHIPS)</i> - Mechanical Characterization of Through-Glass Vias (TGVs) via Nanoindentation
	11:00 AM	<i>Thomas Gallagher</i> - Characterization of a Scintillation-Based Neutron Detector	<i>Caleb Vu (CHIPS)</i> - Reliability Testing of an Underfill and a Thermal Interface Material for Advanced Packaging	<i>Ethan Tan (CHIPS)</i> - Characterizing Copper Microstructures for Enhanced Hybrid Bonding Reliability via Nanoindentation
	11:15 AM	<i>Asher Greenberg</i> - Modernizing an Automated Ionization Chamber for Secondary Radioactivity Standards	<i>Michael Donnelly</i> - Automating a Refrigerant Flammability Experiment	<i>Giorgia Santore (CHIPS)</i> - Formulating epoxy underfill materials for microelectronics packaging
	11:30 AM	<i>Kai Tucker</i> - Novel Monte Carlo Simulation of High-Purity Germanium Detector for Characterization of NIST Standard X-ray Beams	<i>Ethan Nee</i> - Evaluating Dehumidifier Energy Standards Under Real-World Conditions	<i>Justin Chen</i> - Identifying Process Windows for Crystalline GaN Growth Using Molecular Dynamics
	11:45 AM	LUNCH	LUNCH	LUNCH
Time (ET)	Host Info	Host Laboratory: CTL Moderator: <i>Wesley Garey</i> Zoom Moderator: <i>Jian Wang</i>	Host Laboratory: EL Moderator: <i>Katherine Hoffman</i> Zoom Moderator: <i>Theresa Ginley</i>	Host Laboratory: MML Moderator: <i>Tom Forbes</i> Zoom Moderator: <i>Trina Mouchahoir</i>
	12:30 PM	<i>Josslyn Quansah</i> - Analysis of Prompt Variation on RLHF LLM Generated Data Quality		
	12:45 PM	<i>Andrew Waggar</i> - A Look at Decentralized Wireless Networks: Visualizing 5G NR ProSe Scenarios	<i>Victor Mathias</i> - Validating a New Test Method for Pressure Loss in Modern Plumbing Fittings	<i>Isabella Archiello</i> - Using Machine Learning and Atomistic Simulation to Predict Antibody Melting Temperatures
	1:00 PM	<i>Chloe Thompson</i> - Automated Manuscript Compliance Assessment Tool	<i>Bri Grindrod</i> - Pressure Loss Testing of Modern Plumbing Fittings	<i>Maria Grishaeva</i> - The Impact of Surface Amino Acid Mutations on the Solubility of NISTmAb
	1:15 PM	<i>Kevin Song</i> - Edge AI-Enabled Smart LiDAR Sensors for C-V2X ISAC	<i>Sania Manyem</i> - Semantic Interoperability for Cybersecurity in Buildings	<i>Khanh Nguyen</i> - Effect of lipid PEG-ylation on Interactions and Stability of Lipid Particles with Antimicrobial Peptides
	1:30 PM	<i>Joy Roberts</i> - Evaluating V2X Non-Terrestrial Network Performance Through Digital Simulation Tools	<i>Philip Lee</i> - Modeling Photovoltaic Performance from Irradiance Database for Indoor Light Reference Spectra	<i>Eleanor Hamby</i> - Measurement Science and Standards for Scale-Out Distributed Pharmaceutical Manufacturing
	1:45 PM	<i>Jonathan Rich</i> - C-V2X Network Performance Assessment Tool	<i>Anna Linteris (CHIPS)</i> - Characterizing Defects within Silicon Carbide Semiconductors through Hyperspectral Ultraviolet Photoluminescence Spectroscopy	<i>Amie Zeng</i> - Analysis and Visualization of Rapid Street Drug Measurement Data
	2:00 PM	BREAK	BREAK	BREAK
Time (ET)	Host Info	Host Laboratory: CTL & RDCO Moderator: <i>June Lau</i> Zoom Moderator: <i>Chandler Becker</i>	Host Laboratory: EL Moderator: <i>Theresa Ginley</i> Zoom Moderator: <i>Cartier Murrill</i>	Host Laboratory: MML Moderator: <i>Ian Hines</i> Zoom Moderator: <i>Jackie Mann</i>
	2:15 PM	<i>Owen Lin (CTL)</i> - Machine Learning Sensing Abstraction for ISAC System Level Simulation	<i>Dawoon Jung</i> - Curating and Encoding ML Asset Metadata into MLLO	<i>Lindsey Walter</i> - Glowing Microbes: Characterizing and Measuring Soil Microbial Communities via Fluorescence
	2:30 PM	<i>Chitpreet Kaur (RDCO)</i> - Getting Instrumental: Developing a Centralized Instrument Database for Scientific Traceability	<i>Aditya Mishra</i> - Vector Database and RAG Integration for Additive Manufacturing Terminologies	<i>Sophia Yang</i> - Inducible Plasmid Copy Number Systems in Cell-Free and Cell-Based Experiments
	2:45 PM	<i>Sana Girish Rao (RDCO)</i> - Streamlining the NIST Public Data Repository Collection Taxonomy Generation	<i>Mansour Mbow</i> - Knowledge Maintenance in Additive Manufacturing: Leveraging MCP AI Agents for Shop Floor Data	<i>Sheling Cai</i> - Machine Learning Classification of PFAS from Liquid Chromatography-Mass Spectrometry Data

	3:00 PM	Adam Zhu (RDCO) - Usage & Discovery Patterns of the NIST Data Repository	Nimal Muthukumar - Mapping Machine Learning Metadata to the Machine Learning Lifecycle Ontology	Marcos Paulino - Characterization of Oropouche Virus RNA
	3:15 PM	Lucas Rubin (RDCO) - The Data Integrity Project: An Ontological Approach to Research Data Integrity in the Age of Agentic AI	Charles Bradshaw - Benchmarking the Performance of Mobile Manipulator End Effector Trajectories	Shannon Horning (COO) : A Data-Driven Analysis of NIST Research Visibility in the Life Sciences
	3:30 PM	BREAK	BREAK	BREAK
Time (ET)	Host Info	Host Laboratory: ITL	Host Laboratory: EL & TPO	Host Laboratory: MML & COO
		Moderator:	Moderator:	Moderator: Hugh Hayes
		Zoom Moderator: Yolanda Bursie	Zoom Moderator: John Bittman	Zoom Moderator: Jackie Mann
	3:45 PM	Walter Roou - Lost in Terminology: How Everyday Americans Perceive Digital Identity Language	McCarthy Devine (EL) - Development of Standard Test Artifacts and Hard Gaging Kits for the Dimensional Assessment of Internal Channels in Metal Additive Manufacturing	Julia Januszewski - Shining a Light on Kava: Advanced LC-FLD Method Development for Kava RM Characterization
	4:00 PM	Isabella Tai - Investigating DevSecOps for IoT Device Development	Alex Tamagno (EL) - Implementation of IEEE Standard for Robotic Task Representation in ARIAC	Julia Tisaranni - Optimizing the Development of Metal-Organic Frameworks Through Autonomous Design
	4:15 PM	Shaune Yeboah - Modernizing NIST Workforce Guidelines for an Evolving Digital Landscape	Michael Aladejebi (EL) - Temperature Effects on Reciprocity in 6-Port SPHERE	Rachel Lee - Ab Initio Electron-Molecule Scattering Calculations for Methane Using UKRMol+ and ASTRA
	4:30 PM	Mikias Kelela - Looking Through the Noise: Analysis of the Electromagnetic Side-Channel of AES Implementation	Kristina Fleck (TPO) - Technology Transfer Comparative Case Analysis	Tejasvi Subramanya - Molecular Dynamics Simulation for Water Sorption Effects on Epoxy Electronics Packaging
	4:45 PM	Brittney Meza - Streamlining Digital Identity: Practical Tools for Risk Management and Standards Tracking	Joy Ghosh (TPO) -	Siena Iavarone-Garza (CHIPS) - Effect of Semiconductor Packaging Interfaces on the Hygrothermal Response in Polymer Films
	5:00 PM	END for the Day	END for the Day	END for the Day
(CHIPS) - Support for these projects provided by the CHIPS for America R&D Office within NIST.				



**Boulder, CO
2026**



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

NIST Boulder Labs

Communications Technology Lab (CTL)

Material Measurement Lab (MML)

Physical Measurement Lab (PML)

Student Names and Talk Titles (in order of presentation)

Gabriel Rosen-Turits (CTL) (*plenary speaker*) - Radiation in Coplanar Waveguides at High Frequencies

Adriano Cristaldi (PML) (*plenary speaker*) - Optimizing Novel Imaging Protocols to Study Microwave Propagation in the Human Body

Luca Buccilli (CTL) (CHIPS) – Laser Interferometer Measurements of Piezoelectric Materials

Teige Bredin (MML) (CHIPS) – Finite Element Analysis of a Thermal Conductivity Acoustic Resonator

Paul Kliewer (PML) (CHIPS) – Evaluating ML Techniques for Predicting Heisenberg Exchange for MRAM Development

Aryav Gogia (PML) – Diffraction Image Analysis with Artificial Intelligence

William Tyler Reichenberg (CTL) – MmWave Beamforming Measurement for Spectrum Sharing in Next Generation Communication

Max Huang (MML) – Mapping Oxygen-Controlled Modulus Gradients in Vat Photopolymerization by Gap-Dependent Photorheology

Liam A. Hofmann (PML) – Precision Spectroscopy with Laser Frequency Stabilization for Chip-Scale Atomic Voltage Reference

Heng Yao Shen (PML) – Development of RF and Gradient Hardware for 50 mT Low Field MRI

Nicole Kerschner (PML) – Optimization of Laboratory User Interfaces for Magnetic Resonance

Mustafa A. Omran (CTL) – Development of Visualization Frontends for Cellular 5G-NR Measurements

Christopher Hartman (MML) – Computational Exploration and Characterization of Eumelanin

Romer Rosales-Hasek (MML) – Reservoir Replica Exchange for Sampling Inhibitor-Bound ERK2 Conformers

Jason Simental (MML) – AI Document Classification and AI Software Development

Amanda Castillo-Lopez (CTL) – An Exploration of Machine Learning-Based Anomaly Detection for Telecommunications Systems

Daniel Fried (MML) – The Impact of Segmentation Workflows on Microstructure Analysis

Joseph Jung (CTL) – Fingerprinting Cellular Devices with Shape Analysis



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Gabriel Rosen-Turits

Academic Institution: New York University

Major: Physics, Mathematics

Academic Standing Junior
(Sept. 2026):

Future Plans Physics PhD (Hopefully)
(School/Career):

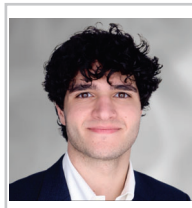
NIST Laboratory, Division, and Group: CTL, RF Technology Division, Guided Wave Electromagnetics Group

NIST Research Advisor: Nathan Orloff

Title of Talk: Radiation in Coplanar Waveguides at High Frequencies

Abstract:

At sufficiently high frequencies, coplanar waveguides (CPWs) exhibit an effect attributed to radiation. This effect appears as an increase in the measured resistance and capacitance per unit length. While a phenomenological model for the effects of radiation does exist, an experiment designed to test this model would strengthen its standing in the literature. Here, we designed an experiment to test the model up to 220 GHz by varying the geometry of 15 different CPW calibration kits. The experiment examines how well our data agrees with the predictions of the phenomenological model. The different calibration kits allow us to measure a correlation between geometry and radiation. We demonstrate measurements in alignment with the model's predictions and show that both smaller center conductor width and smaller gap size minimize the amount of radiation observed. Radiation has previously been a substantial source of error in CPW measurements, but with the ability to confidently characterize it and knowledge of how to minimize it, that error can be avoided. This contributes to NIST's larger goal of making measurements of complex permittivity fully traceable.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Adriano Cristaldi

Academic Institution: Vanderbilt University

Major: Biomedical Engineering

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): Medical Device Research and Innovation

NIST Laboratory, Division, and Group: PML, Applied Physics Division, Magnetic Imaging Group

NIST Research Advisor: Stephen Russek and Karl Stupic

Title of Talk: Optimizing Novel Imaging Protocols to Study Microwave Propagation in the Human Body

Abstract:

Microwave radiation underpins a wide range of technologies from cell phone communication to microwave ablation therapy to directed energy weapons. However, at microwave frequencies, the human body is an efficient absorber of energy. Thus, accurate measurements of microwave propagation in the body are critical, yet they remain challenging. Conventional safety assessments use numerical modeling to determine heating effects caused by the microwaves, but verification of these models is limited, as it requires perturbative probes that can only make local and indirect measurements.

Hyperpolarized low-field MRI is a novel technique to image microwave propagation and could greatly improve measurement standards and safety protocols for microwave exposure and therapies. This technique involves mixing stable free radicals into a sample, which can then absorb angular momentum from microwaves and transfer it to the surrounding water proton spins, polarizing them. This polarization can be imaged through conventional magnetic resonance imaging (MRI).

This project aims to optimize hyperpolarized low-field MRI in two facets: improving signal detection and studying the resonance and focusing effects that could arise in the body. Signal detection was enhanced by fine tuning the frequency of the microwaves imaged to optimize resonance between the microwave radiation and free radicals. The fine-tuning process was automated to allow implementation of different free radicals with increased responsivity. An arbitrary waveform generator was integrated to study impacts of waveform shape. Lastly, to image microwave penetration in a complex system, increasingly accurate tissue mimics were developed, specifically modeling the inner ear. Continuing to expand on hyperpolarized low-field MRI could greatly improve our understanding of microwave propagation in the body, which will be critical as microwaves become ever more present in technology.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Luca Buccilli

Academic Institution: Dartmouth College

Major: Physics

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** PhD in atomic physics

**NIST Laboratory,
Division, and Group:** CTL, RF Technology Division and Guided Wave Electromagnetics Group

**NIST Research
Advisor:** Bobby Lirette and Angela Stelson

Title of Talk: Laser Interferometer Measurements of Piezoelectric Materials

Abstract:

Piezoelectric materials are widely used in cell phones as radio frequency (RF) filters. Industry requires knowledge of the piezoelectric coefficient of these materials to effectively design them. The piezoelectric coefficient of a material determines the amount it will displace per unit applied electric field. My project was to measure the displacement amplitude of surface acoustic waves (SAWs) generated by interdigitated transducers (IDTs) on a NIST-fabricated chip using a laser interferometer. RF filters are often designed using similar IDT devices. Laser interferometers work by using the interference of light to measure displacements on the order of the wavelength of the light. Single frequency interferometers are highly unstable due to air currents and temperature fluctuations. My work consisted of aligning an interferometer and stabilizing it using an automated proportional-integral-derivative feedback loop. I then characterized the resonant frequency and the quality-factor of the IDT chips to identify suitable driving frequencies for each. Next, I plan to use motion controllers to scan across the surface of the IDTs and take automated displacement measurements for each of the chips. Measuring these displacements enable the characterization of the piezoelectric constant, knowledge of which is essential to the communications industry.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Teige Bredin

Academic Institution: Kalamazoo College

Major: Chemistry and Physics

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Attend graduate school in materials science or chemical engineering

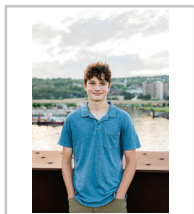
**NIST Laboratory,
Division, and Group:** MML / Applied Chemicals and Materials Division / Thermophysical Properties of Fluids Group

**NIST Research
Advisor:** Dr. Karim Al-Barghouti

Title of Talk: Finite Element Analysis of a Thermal Conductivity Acoustic Resonator

Abstract:

In semiconductor manufacturing, mass flow controllers dictate gas composition in etching and deposition chambers; accurate flow metering is critical for improving yield and throughput. Flow controllers operate on physics-based models that depend on geometry and measurements of transport properties. Yet, semiconductor process gases are often corrosive, preventing us from using traditional methods of measurement. We are developing an alternative approach for measuring thermal conductivity based on acoustic resonators and interferometry principles. Resonators offer the benefit of no moving parts, small gas volumes, and compatibility with corrosion-resistant materials. Acoustic resonators have been optimized for speed of sound measurement, but transport properties like thermal conductivity remain underdeveloped. Without an established technique to follow, finite element analysis is being used to guide the design and modeling of a thermal conductivity acoustic resonator. Thermoviscous acoustic simulation quantifies thermal and viscous losses, and from this, thermal conductivity is found. It requires computationally expensive calculations, so a challenge is designing a simulation that will accurately reflect physics without using excessive resources. Through simulation and modeling, this study develops a framework for an instrument that can experimentally yield thermal conductivity. This instrument can be used to obtain thermophysical property data on semiconductor process gases to support improvements in chip production.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Paul Kliewer

Academic Institution: Colorado School of Mines

Major: Physics

**Academic Standing
(Sept. 2026):** Graduated

**Future Plans
(School/Career):** Physics

**NIST Laboratory,
Division, and Group:** Physical Measurement Laboratory, Applied Physics Division, Spin Electronics Group

**NIST Research
Advisor:** Matthew Pufall, Charles Swindells

Title of Talk: Evaluating ML Techniques for Predicting Heisenberg Exchange for MRAM Development

Abstract:

Magnetic random-access memory (MRAM) is an emerging spintronic technology slated to replace Flash in many future applications due to its nonvolatility, high write speeds, and high endurance. MRAM uses ultrathin (<1.5 nm) magnetic layers to store information and spin currents to write it. At these length scales, bulk values for critical parameters are not accurate, as Bloch's law for ferromagnetism breaks down for the thin magnetic layers used in MRAM. Therefore, developing a combination of advanced measurements and simulations is necessary for MRAM development. The Heisenberg exchange constant is a critical parameter for MRAM, as it dictates a sample's ferromagnetism and helps define the energy barrier that ensures data retention in MRAM elements. Currently, industry determines the Heisenberg exchange of their MRAM stacks by fabricating and measuring many devices. Faster MRAM development can be realized by determining the Heisenberg exchange constant at the thin-film level. In this work, we developed a machine learning model to predict the Heisenberg exchange constant of sputtered thin film stacks based on average magnetization versus temperature curves acquired with SQUID-VSM. The accuracy of the model was validated using Brillouin light scattering (BLS), which probes the spin waves of magnetic materials to determine the film's magnetic properties.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Aryav Gogia

Academic Institution: Purdue University

Major: Aerospace Engineering

Academic Standing Sophomore
(Sept. 2026):

Future Plans Graduate School
(School/Career):

NIST Laboratory, Division, and Group: PML, Applied Physics Division, Quantitative Nanostructure Characterization Group

NIST Research Advisor: Dr. Kris Bertness and Dr. Edwin Supple

Title of Talk: Diffraction Image Analysis with Artificial Intelligence

Abstract:

Current semiconductor devices rely increasingly on precise fabrication techniques to improve the performance and the efficiency of these electronic systems. These two projects explore adjacent applications in applying machine learning (ML) techniques to next generation semiconductor material growth characterization. The first of the complimentary projects focuses on reflection high-energy electron diffraction (RHEED). Diffraction images are collected from an electron beam bouncing off a wafer during molecular beam epitaxy (MBE) crystal growth. The pattern is collected on a fluorescent screen on the opposite side of the chamber. Using ML techniques, we determine whether the RHEED patterns appear streaky, meaning the surface is smooth and GaN formed well, or if the image gets spotty, meaning the surface is rough and the GaN did not form well. The second project focuses on Transmission Electron Microscopy (TEM) Position-Averaged Convergent-Beam Electron Diffraction (PACBED) images. Because fine details in PACBED patterns vary uniquely with different material and thickness combinations, we plan to predict local lamella thickness by training ML models on simulated data and deploying them on experimental patterns. By automating PACBED pattern analysis, we aim to improve the accuracy and precision of lamella thickness measurement. This measurement improvement would further nanoscale electric field measurement using the TEM, which depends on lamella thickness as an input for quantification.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: William Tyler Reichenberg

Academic Institution: Purdue University

Major: Mechanical Engineering

Academic Standing Sophomore
(Sept. 2026):

Future Plans Complete my B.S. in Mechanical Engineering
(School/Career):

NIST Laboratory, Division, and Group: Communications Technology Laboratory, Spectrum Technology and Research Division, Shared Spectrum Metrology Group

NIST Research Advisor: Dr. Yao Ma

Title of Talk: MmWave Beamforming Measurement for Spectrum Sharing in Next Generation Communication

Abstract:

As next-generation communication systems expand, maximizing spectral efficiency for spectrum sharing within the millimeter-wave (mmWave) band is critical. This study presents an automated testing framework for mmWave beamforming measurement for spectrum sharing in next generation communication, incorporating precise beam alignment and side-lobe suppression. To investigate beamforming, software-defined radios (SDRs) and phased-array (PA) units were utilized to design and measure beam alignment accuracy. To facilitate programmatic Over-the-Air (OTA) angular sweeping, this research developed a custom Python package for controlling an iOptron motorized mount that rotates the PA units. This automated framework was paired with a complete software migration of existing MATLAB control code into Python to provide greater open-source programming flexibility and efficient data logging. The goals of this project are the capability to align the beam within a 1-2 degree root mean square (RMS) error margin by measuring the signal-to-noise ratio (SNR) of continuous wave and chirp signals and to demonstrate end-to-end communication capability. Ultimately, this framework directly benefits critical deployment applications such as satellite-terrestrial spectrum sharing, dense urban network structures, and automated hardware-in-the-loop calibration.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Max Huang

Academic Institution: University of Chicago

Major: Chemical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): PhD in Materials Science and Engineering

NIST Laboratory, Division, and Group: MML / Applied Chemicals and Materials Division / Nanoscale Reliability Group

NIST Research Advisor: Dr. Rion Wendland and Dr. Jason Killgore

Title of Talk: Mapping Oxygen-Controlled Modulus Gradients in Vat Photopolymerization by Gap-Dependent Photorheology

Abstract:

Vat photopolymerization, a resin-based form of 3D printing, builds parts by curing liquid photopolymer in a layer-by-layer method. However, light attenuation and oxygen inhibition impose steep through-thickness gradients in conversion and modulus that govern feature fidelity, mechanical performance, and interlayer adhesion. Here we map the oxygen inhibition contribution using gap-dependent photorheology, which reconstructs the depth-resolved shear modulus $G(z)$ of an optically thick photopolymer from bulk photorheology measured across a series of rheometer gap heights. To control oxygen as an independent variable, we introduce an oxygen-permeable membrane as a tunable diffusion boundary at the illuminated window and compare it against an oxygen-impermeable glass boundary at matched irradiances, isolating the through-thickness oxygen contribution set by the permeable boundary. Reconstructing $G(z)$ on both boundaries, we quantify the thickness () of the under-converted dead zone, the thin liquid layer that persists due to oxygen inhibition and diffusion from the permeable boundary, and validate the model against experimentally obtained values. We anticipate that contracts systematically as irradiance rises, with radicals depleting boundary oxygen more rapidly, a dependence captured by a one-dimensional reaction-diffusion model coupling oxygen transport, radiant exposure, and conversion. Because this under-converted dead zone region is vital to the bonding interface between successive layers, we extend the framework to predict single-layer lamination-failure threshold and multilayer stiffness on oxygen-permeable boundaries, anticipating an optimal that maximizes interlayer adhesion. Our methodology thereby provides an accessible route to map and tune intra- and inter-layer stiffness in vat photopolymerization applications.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Liam A. Hofmann

Academic Institution: University of California, Davis

Major: Physics

Academic Standing (Sept. 2026): 1st year PhD student

Future Plans (School/Career): PhD in Applied Physics at Northwestern, then hopefully work as a physicist in industry or at a national lab

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Time and Frequency Division, Atomic Devices and Instrumentation Group (688.90)

NIST Research Advisor: Ying-Ju Wang

Title of Talk: Precision Spectroscopy with Laser Frequency Stabilization for Chip-Scale Atomic Voltage Reference

Abstract:

Stable, precise voltage references are foundational to modern metrology. At NIST's Atomic Devices and Instrumentation Group, researchers develop vapor cell voltage references that achieve stability via feedback from cesium absorption spectra. To achieve an ultra-precise uncertainty threshold of under one part per million (ppm), the cesium atoms must be addressed using a frequency-stabilized laser locked to the resonant modes of an ultrastable optical cavity.

My work on this project centers on developing a multi-wavelength cavity lock capable of supporting 852 nm and 509 nm for conventional electromagnetically induced transparency (EIT) excitation, as well as 656 nm for a degenerate two-photon transition from the ground state to various Rydberg states in cesium. To achieve this, we utilize a Pound-Drever-Hall (PDH) locking architecture. The cavity is first stabilized using a laser resonant with an easily accessible, single-photon cesium transition to the first excited state (852 nm). The laser is phase-modulated, which yields an error signal from the transmitted light that is used to adjust and stabilize the cavity dimensions. Additional frequencies can then be locked onto the stabilized cavity using a similar phase-detection loop.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Heng Yao Shen

Academic Institution: Colorado School of Mines

Major: Electrical Engineering

Academic Standing Junior
(Sept. 2026):

Future Plans Master's in Quantum Engineering
(School/Career):

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Applied Physics Division, Magnetic Imaging Group

NIST Research Advisor: Stephen Ogier

Title of Talk: Development of RF and Gradient Hardware for 50 mT Low Field MRI

Abstract:

Low-field magnetic resonance imaging (MRI) at 50 mT presents an opportunity to move diagnostic imaging from resource-intensive hospitals into low-resource or point-of-care settings. MRIs use nuclear magnetic resonance to polarize water in a magnetic field, excite their spins with radio frequency (RF) pulses, and record the resulting signals as they relax. NIST has a 50 mT permanent magnet system that acquires relaxation data, but it lacks the hardware for imaging. To realize this system's potential and enable imaging for the first time, it is imperative to design accessible, open-source hardware components.

The hardware to acquire images includes three critical subsystems: gradient coils, a Transmit/Receive (T/R) switch, and receiver preamplifier boards. Gradient coils, which spatially encode the magnetic field to map signals into an image, underwent CAD modeling and prototyping to optimize manufacturability and performance within the low-field constraints. For the RF chain, an active T/R switch was designed to protect sensitive receiver electronics from RF excitation pulses. The switch optically isolates RF and control signals to reduce noise and signal leakage. It also employs an asymmetric RC delay network to ensure operational dead time and prevent shoot-through currents. Finally, dedicated preamplifier boards were designed to maximize signal-to-noise ratio and provide active coil decoupling. This work builds on recent high-input impedance decoupling methods that use high-impedance preamplifiers and transformers. For a low-field system, we hypothesize that an operational amplifier (op-amp) based architecture can provide sufficient bandwidth while offering high input impedance and configurable gain.

The design, prototyping, and testing of RF and gradient hardware advances the research of accessible low-field MRI systems. By bridging the gap between data acquisition and imaging on the 50 mT design, this work contributes critical, component-level hardware designs to open-source imaging.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Nicole Kerschner

Academic Institution: Scripps College

Major: Computer Science and Mathematics

Academic Standing (Sept. 2026): Graduated with Bachelor's Degree

Future Plans (School/Career): Graduate school/career in Human Computer Interaction

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Applied Physics Division, Magnetic Imaging Group

NIST Research Advisor: Karl Stupic

Title of Talk: Optimization of Laboratory User Interfaces for Magnetic Resonance

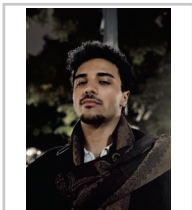
Abstract:

Magnetic resonance imaging (MRI) is used in both scientific research and medical environments, most notably to diagnose and monitor diseases. The magnetic imaging group at NIST develops methods and standards for these technologies for lab and clinical settings. My efforts this summer were to develop software to optimize the user experience when working with magnetic resonance systems at NIST.

To facilitate monitoring of critical environmental parameters, I developed a centralized system to aggregate data for the MRI Biomarker lab, which was previously collected and displayed independently. To consolidate this data, I created a network over which the sensors could communicate with a central data collection point and developed software to aggregate and display it. This allows users to easily know that the lab is in a safe state to continue with research and provides protection if a parameter deviates from expected values.

Similarly, the low-field human imaging system had an existing hardware protection system that, while functional, was not user friendly. To increase ease-of-use, I developed a Python program to pull, process, and display data from the existing system in a graphical user interface (GUI). This new system automatically provides up-to-date information in an intuitive display with minimal required action from the user.

A further user interface I worked on was the construction of pulse sequences for MRI systems. These pulse sequences define the timing and magnitude of radiofrequency and gradient pulses that generate images. Working alongside researchers at Vanderbilt University and Case Western University, I furthered development of an interpreter between Pulseseq, an open-source framework for the development of pulse sequences, and TecMag consoles, which are used in the MRI labs at NIST. This provided a more streamlined user experience in pulse sequence development and supports standardization of MRIs between lab research and clinical settings.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Mustafa A. Omran

Academic Institution: The University of Texas at Austin

Major: Electrical & Computer Engineering

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): Law School (Patent & Intellectual Property Law)

NIST Laboratory, Division, and Group: Communication Technology Laboratory | Spectrum Technology and Research Division | Applied Systems Metrology Group

NIST Research Advisor: Dr. Aric Sanders & Dr. Dan Kuester

Title of Talk: Development of Visualization Frontends for Cellular 5G-NR Measurements

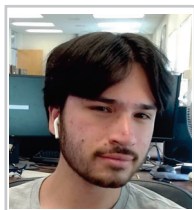
Abstract:

As fifth-generation cellular systems expand into frequency bands used by existing services, reliable measurements are needed to determine whether the systems may interfere with one another. One NIST study examines whether the antenna used to monitor a deployed cellular signal changes the measured received-power statistics. The experiment compares simultaneous measurements from an omnidirectional reference antenna and a directional linear array.

StriQt is a NIST-developed collection of open-source Python packages for acquiring and analyzing radio signals from software-defined radios. It converts raw receiver data into calibrated measurements with physical units and produces products such as spectrograms, power spectral density estimates, and cellular synchronization results. StriQt is designed mainly for scripted data collection and analysis, but researchers also need to see what the system is measuring while an experiment is running.

To meet this need, several live visualization interfaces were developed, including desktop, terminal, networked client-server, and browser-based versions. The interfaces allow researchers to view one or more receiver channels, change radio and analysis settings, and remotely monitor measurements from a computer or mobile device. The software can automatically detect supported radios, check requested settings against device and analysis limits, and recover from receiver errors without requiring a full restart. Acquisition and signal processing run separately so the radio can continue collecting data while plots are updated.

These tools help researchers find active signals, verify that the equipment is configured correctly, and compare antenna measurements before starting a long acquisition. This reduces the chance of collecting unusable data and supports more reliable interference and spectrum-sharing studies.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Christopher Hartman

Academic Institution: Juniata College

Major: Biochemistry

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Graduate school

NIST Laboratory, Division, and Group: MML / Applied Chemicals and Materials Division / Thermodynamics Research Center

NIST Research Advisor: Dr. Vladimir Diky and Dr. Ala Bazyleva

Title of Talk: Computational exploration and characterization of Eumelanin.

Abstract:

Strains of melanized fungi appear well adapted to high radiation environments such as those in the ruins of Chernobyl, being observed to grow in the direction of radioactive particles in soil, leading some to speculate that melanin holds properties like pigments such as chlorophylls utilized in photosynthesis. This project investigates the electronic structure of melanin polymers composed of monomer units of 5,6-dihydroxyindole (DHI) and 5,6-dihydroxyindole-2-carboxylic acid (DHICA). This is done through the usage of the QM software ORCA for the optimization of polymer geometry and to obtain spin density diagrams. MRCC was utilized to obtain adiabatic ionization potential (IP). It is hypothesized that energy transduction happens through the reduction of NAD⁺, or the oxidation of NADH. If NAD⁺ is being reduced to NADH, this process could provide an alternative source of NADH for the electron transport chain, contributing directly to ATP production. If NADH is being oxidized to NAD⁺, the role this process plays in the accelerated growth is less direct. PARP repair enzymes are more expressed in areas of intense radiation. These enzymes consume a significant amount of NAD⁺ to perform their function. The oxidation of NADH to NAD⁺ could regenerate lost NAD⁺ for use in this process. The issue with this theory is that the NAD⁺ consumed through PARP is not done through a redox reaction and thus could not be regenerated through oxidation via melanin on its own. There would need to be a significant surplus of NADH that could not be utilized by PARP; the function of melanin then being to mediate the ratio of NADH to NAD⁺. This project will not confirm either pathway but will act as a first step to investigating the energetic feasibility of each one.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Romer Rosales-Hasek

Academic Institution: University of California, Santa Barbara

Major: Physics

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Graduate school > Postdoc > professorship or research job

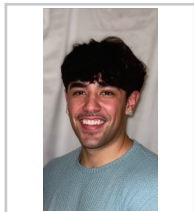
**NIST Laboratory,
Division, and Group:** MML / Materials Data Division / Theory, Modeling, and Simulation Group

**NIST Research
Advisor:** Dr. Demian Riccardi and Dr. Theodore Fobe

Title of Talk: Reservoir Replica Exchange for Sampling Inhibitor-Bound ERK2 Conformers

Abstract:

In cellular biology, the RAS-RAF-MEK-ERK pathway is an important signaling cascade that mediates cell growth, migration, and differentiation. Dysregulation of proteins in this pathway can lead to uncontrolled cell proliferation, a hallmark of many cancers. Being the final effector in this central cascade, ERK2 is a crucial target for therapeutic drugs, yet its activation mechanism (driven by the dynamics of its activation loop) remains poorly understood. From our 2023 long conventional molecular dynamics (MD) study and subsequent enhanced sampling studies (REMD and REST2), we identified that the loop repeatedly settles into metastable contacts with the enzyme core for ~500 ns to several microseconds before unsetting and forming new contacts. Separately, NMR experiments have identified two conformational states labeled L and R; whether these states correspond to the computed settled states is unclear, since the interconversion rate between states differs. To better understand the relationship between experiment and simulation while reusing the settled states already identified, we implemented a reservoir REMD workflow that uses our previously computed conformers to sample more efficiently and explore new states. We applied this method to ERK2 bound to three conformation-selective inhibitors (VTX11e, SCH772984, GDC0994) to test whether binding biases particular settled states. The pipeline offers a reusable, efficient route to sampling ERK2's landscape, and it can be generalized to other systems where prior sampling can seed new studies.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Jason Simental

Academic Institution: Colorado State University

Major: Electrical Eng. & Computer Sci

**Academic Standing
(Sept. 2025):** Senior

**Future Plans
(School/Career):** Graduate School

**NIST Laboratory,
Division, and Group:** MML / Applied Chemicals and Materials / Thermodynamics Research Center

**NIST Research
Advisor:** Dr. Demian Riccardi

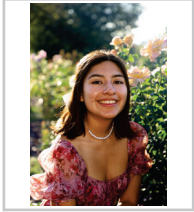
Title of Talk: AI Document Classification and AI Software Development

Abstract:

Analysts at NIST's Thermodynamics Research Center (TRC) curate thermophysical property data extracted from research papers spanning many journals in the organic and metallic materials domains. Finding the small fraction of relevant papers within a large literature is a costly bottleneck, and an existing model handles only part of the problem for one domain. This work develops the machine-learning component of a paper relevance scoring tool to widen that bottleneck, and, in doing so, tests a discipline for specifying complex software with AI assistance before any code is written.

The central methodological question is whether a system can be fully specified through a hierarchy of planning documents in which each layer constrains the one below it and no layer may contradict the layer above it, so that an AI agent can later build from the specification rather than improvising.

Our evaluation demonstrates that this hierarchical discipline successfully catches structural flaws at design time, when they are still cheap to fix. By forcing a clean separation between non-negotiable correctness properties and deferrable implementation formats, the framework exposed system vulnerabilities, including label trust imbalances, identity resolution gaps, and model reproduction limits, long before a single line of code was written. Ultimately, this work provides a reproducible pattern for using AI assistance safely in complex software engineering, proving that systemic invariants can be rigidly guaranteed at the specification layer independently of subsequent implementation details.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Amanda Castillo-Lopez

Academic Institution: Colorado School of Mines

Major: Applied Mathematics and Statistics

Academic Standing
(Sept. 2026): Junior

Future Plans
(School/Career): M.S & PhD in Applied Mathematics and Statistics

NIST Laboratory,
Division, and Group: Communications Technology Laboratory, Spectrum Technology and Research Division, Shared Spectrum Metrology Group

NIST Research
Advisor: Jeanne Quimby

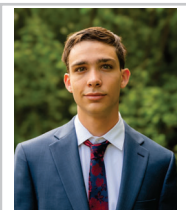
Title of Talk: An Exploration of Machine Learning-Based Anomaly Detection for Telecommunications Systems

Abstract:

As individuals, corporations, and government institutions continue to rely heavily on cellular networks for data transmission, vulnerabilities in radio access networks (RAN) are a critical cybersecurity concern. The Packet Data Convergence Protocol (PDCP) layer of the radio protocol stack is of particular interest, as it enables encryption of the data sent between base stations and user equipment. This research explores whether higher-layer PDCP anomalies can be detected at the physical layer using in-phase and quadrature (IQ) data.

Using data collected from the network diagnostics of a user equipment (UE) emulator (TM500), a previous study established that the reference signal received quality (RSRQ) power metric is an effective measurand to distinguish between encryption being on or off. The present study analyzes data collected during the same measurement campaigns but attempts detection using IQ data captured by a vector signal analyzer (VSA). While the previous study demonstrated that unauthorized security setting changes at the PDCP layer are detectable from a UE's diagnostic logs, this approach evaluates whether the same detection is possible from the perspective of a passive, external intercepting entity.

Due to statistical dependence, testbed instability, and distribution differences compared to the data collected on the TM500, this present study investigated additional methods to complement the statistical ones used in the previous study. This work investigates a machine learning approach to classify cipher states despite the data's inherent dependence and temporal instability. By evaluating these models, this study explores how specific physical-layer attributes relate to PDCP security configurations. Ultimately, these insights expose vulnerabilities regarding cipher state leakage to passive interception.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Daniel Fried

Academic Institution: Binghamton University

Major: Chemistry

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Graduate School in Materials Science and Engineering

**NIST Laboratory,
Division, and Group:** MML / Applied Chemicals and Materials Division / Fatigue and Fracture Group

**NIST Research
Advisor:** Dr. Austin Gerlt, Dr. Jake Benzing, and Dr. Nik Hrabe

Title of Talk: The Impact of Segmentation Workflows on Microstructure Analysis

Abstract:

Electron Backscatter Diffraction (EBSD) is an electron microscopy technique for obtaining micron-scale orientation maps. It is widely used to produce grain maps to characterize the microstructure of polycrystalline materials. To obtain quantitative metrics describing a material's grain structure, raw EBSD data must first undergo a series of processing steps many of which lack a universally accepted methodology. Also, many EBSD data processing decisions are embedded within the analysis software itself. Consequently, identical EBSD datasets can produce different microstructural metrics depending on the analysis software used. Therefore, researchers must be aware of the biases and variability introduced due to the hardcoded decisions made within their chosen software.

This work quantifies the variability in EBSD-derived microstructural metrics introduced by software choice. Statistical analyses were performed on microstructural metrics generated by multiple software packages using datasets spanning different materials, acquisition parameters, and artificially altered indexing conditions. These results show that software-dependent differences in microstructural metrics are statistically significant and can contribute more uncertainty to Hall – Petch predicted yield strength than experimental tensile testing variability. In addition, factors such as instrumental data collection choices, data quality, and material state can amplify the biases introduced from choices in software. These findings highlight the importance of accounting for software-induced variability when interpreting EBSD measurements and comparing results across studies.



SURF Student Colloquium

NIST – Boulder, CO

August 3-6, 2026

Name: Joseph Jung

Academic Institution: George Mason University

Major: Mathematics and Computer Science

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** PhD in Computational/Applied Mathematics

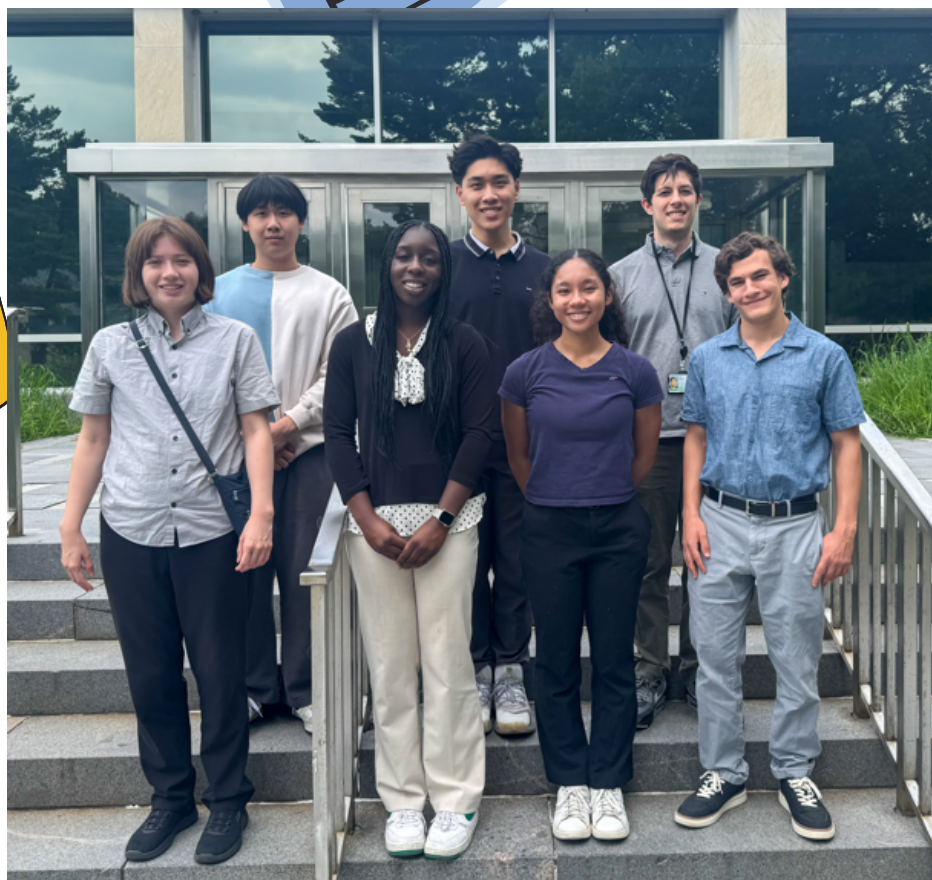
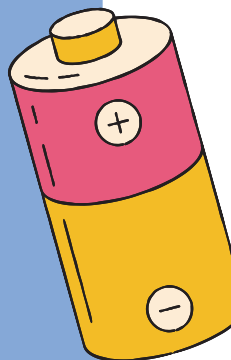
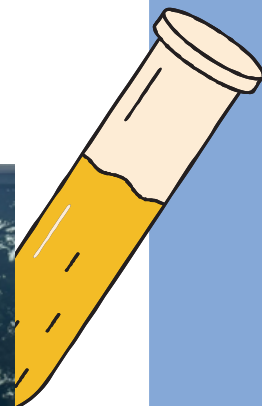
**NIST Laboratory,
Division, and Group:** Communications Technology Laboratory, RF Technology Division, High-Speed Waveform
Metrology Group (672.03)

**NIST Research
Advisor:** Jacob Rezac

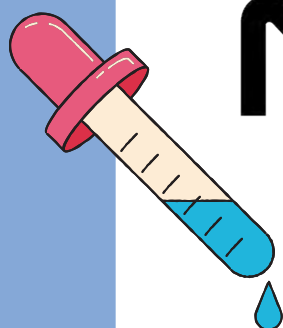
Title of Talk: Fingerprinting Cellular Devices with Shape Analysis

Abstract:

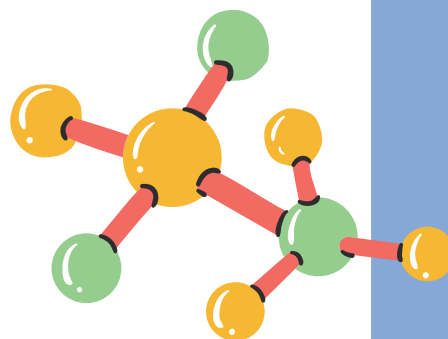
Radio frequency (RF) fingerprinting provides a vital mechanism for authenticating devices and detecting hardware tampering. A key step in RF fingerprinting is robust cellular device classification; prior work has established a library of RF measurements of commercial off-the-shelf user equipment (UE) to test classification methods. Summary statistics of measurements, such as mean and variance, are often sufficient for highly accurate classification of UE brands. However, finer-resolution identification, such as classification of a specific UE, is difficult to achieve from these simple features. Our research introduces a new way to represent a broader class of patterns with the goal of identifying each specific UE. We treat measured RF signals as shapes in the two-dimensional plane and we build classifiers with tools from mathematical shape and data analysis, such as kernel density estimation (KDE) and separable shape tensors (SSTs). We assess this classification framework with convergence studies on the SST distances of KDE contours across varying sample sizes and bandwidths using known probability measures.



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TECHNOLOGY
LABORATORY



2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Communications Technology Laboratory (CTL) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Josslyn Quansah - Analysis of Prompt Variation on RLHF LLM Generated Data Quality

Andrew Waggoner - A Look at Decentralized Wireless Networks: Visualizing 5G NR ProSe Scenarios

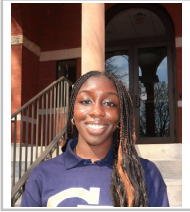
Chloe Thompson - Automated Manuscript Compliance Assessment Tool

Kevin Song - Edge AI-Enabled Smart LiDAR Sensors for C-V2X ISAC

Joy Roberts - Evaluating V2X Non-Terrestrial Network Performance Through Digital Simulation Tools

Jonathan Rich - C-V2X Network Performance Assessment Tool

Owen Lin - Machine Learning Sensing Abstraction for ISAC System Level Simulation



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Josslyn Quansah

Academic Institution: Georgia Institute of Technology

Major: Computer Science

**Academic Standing
(Sept. 2026):** Sophomore

**Future Plans
(School/Career):** Masters in Artificial Intelligence, Specializing in AI Safety and Assurance

**NIST Laboratory,
Division, and Group:** Communications Technology Laboratory (CTL), Quantum Computing Division

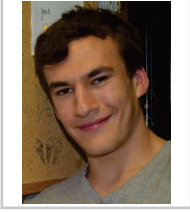
**NIST Research
Advisor:** Michael Dawson

Title of Talk: Analysis of Prompt Variation on RLHF LLM Generated Data Quality

Abstract:

During the training process of a Large Language Model (LLM), extensive datasets are used to tune billions of parameters by reproducing patterns in grammar, syntax, and word order. Following this, a process called Reinforcement Learning from Human Feedback (RLHF) can be used to align the model's input-output mapping more closely with human preferences and safety guidelines. RLHF is essential to creating trustworthy AI, as it mitigates the effectiveness of jail-breaking and RAG poisoning. However, RLHF requires large, human-annotated datasets which are both time and resource intensive. One approach to reducing the cost of RLHF is emerging through producing synthetic data, which can serve as a supplement to human-annotated data.

In this project, I capitalize on the generative capabilities of LLMs to produce high-utility synthetic data that emulates the statistical characteristics of gold-standard RLHF tabular datasets. I analyze how prompt parametrization influences the diversity and robustness of synthetic prompt-response pairs. The quality of the resulting data is evaluated using semantic embedding distance, reward model scoring, distributional analyses, and a variety of lexical metrics.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Andrew Waggoner

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): Computer Science Graduate Degree

NIST Laboratory, Division, and Group: Communications Technology Laboratory, Wireless Networks Division 673

NIST Research Advisor: Wesley Garey

Title of Talk: A Look at Decentralized Wireless Networks : Visualizing 5G NR ProSe Scenarios

Abstract:

In the cellular network standards for 5th Generation wireless (5G) New Radio (NR), the Sidelink (SL) interface allows User Equipment (UE) devices to directly interface with each other without the need for the broader network infrastructure. With NR Proximity Services (ProSe), devices can dynamically discover other nearby devices to create an ad hoc network. These Mobile Ad Hoc Networks (MANETs) have great potential in the realm of public safety, where traditional network infrastructure may be overloaded, damaged, destroyed, or non-existent. UEs can send messages directly to neighbors via a single-hop link, but can also use other UEs in the MANET as a relay to achieve multi-hop communication. Using the open-source, network simulator, "ns-3," researchers in NIST's Wireless Network Division (WND) are developing extensions to model NR ProSe standards. These simulation models are then used to understand the technology at a system level by observing its behavior under various scenarios, conditions, and configurations. The insights gained from these simulations are then used to publish research papers and support their collaborative work with standards body organizations to enhance the technology.

In this talk, I will discuss my role in the development and utilization of WND's visualization tool for ns-3 called, "NetSimulyzer," which can playback ns-3 simulations with dynamic visual displays. Without this tool, users must develop custom scripts to post process a multitude of files to make observations and create visuals. However, with NetSimulyzer and the features that I have added, users can inherently display the scenario topology, plot meaningful charts, and replay the latest NR ProSe simulations. I catalogue the various features that I have added in Netsimulyzer and extended in ns-3 to display many relevant aspects of the MANET simulations for WND's work modeling NR ProSe. These features include displaying direct UE links, routing protocol paths, packet volume, resource utilization, and more.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Chloe Thompson

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): Product Management or Higher Education and pursuing an MBA

NIST Laboratory, Division, and Group: Communications Technology Laboratory, Wireless Networks Division

NIST Research Advisor: Richard Rouil

Title of Talk: Automated Manuscript Compliance Assessment Tool

Abstract:

Manuscripts at the National Institute of Standards and Technology (NIST) must be reviewed for numerous formatting-related guidelines before further peer review and publication. However, this process is currently very tedious and time-consuming, as it is done manually. Furthermore, some errors, such as spacing errors, are difficult to identify, and not all errors will be caught by the human eye, resulting in errors remaining in published manuscripts.

We built a Large Language Model (LLM) pipeline in Python using the NIST RChat API, which allows users to upload draft manuscripts in PDF, Word, or Text format and receive a list of any formatting violations found. The pipeline's knowledge base includes an array of simpler (non-content-based) manuscript guidelines, such as SI unit use, unit symbol spacing, terminology use, and figure referencing. Each guideline has a unique LLM prompt to thoroughly describe the rule and instruct the LLM to flag violations. The pipeline iterates through this array, querying each guideline individually alongside a general system prompt, and appends any violations to a JSON-formatted string, which is ultimately parsed and displayed on the interface.

Furthermore, the application features an option on the landing page to select which guideline categories to assess, a progress bar, and tracking of which rules the manuscript has been reviewed for, to improve the user's experience.

The goal of this project is to build a functional, accurate, and deployable pipeline for NIST manuscript authors and reviewers to use. If successful, it will significantly reduce the time required for manuscripts to be reviewed and published.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Kevin Song

Academic Institution: Vanderbilt University

Major: Computer Science

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Software Engineer / AI/ML Engineer / Startup Founder

**NIST Laboratory,
Division, and Group:** CTL, Wireless Networks Division, Radio Access and Propagation Metrology Group

**NIST Research
Advisor:** Jian Wang

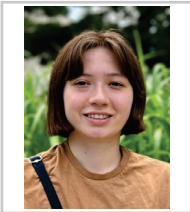
Title of Talk: Edge AI-Enabled Smart LiDAR Sensors for C-V2X ISAC

Abstract:

As autonomous vehicles become a global transportation norm, their traditional onboard sensors face line-of-sight limitations that can obscure crucial details in complex driving environments. A promising solution is Integrated Sensing and Communication (ISAC), a key component of emerging networks like 6G that consolidates sensing and communication into a unified, highly efficient system. Rather than relying solely on vehicle-mounted sensors, placing sensors onto transportation infrastructure (such as traffic lights) can provide vehicles with a comprehensive, bird's-eye view of the road.

To bring this infrastructure-based approach to life, this project pairs an elevated LiDAR sensor with Cellular Vehicle-to-Everything (C-V2X) communication to actively eliminate critical intersection blind spots. Utilizing Edge-AI computing, the LiDAR executes onboard object detection and classification, seamlessly transmitting the processed results to a Road-Side Unit (RSU). This edge-integrated architecture enables lightning-fast safety alerts—such as notifying approaching vehicles of a crossing pedestrian—reducing network latency, optimizing execution, and improving road safety.

To validate this framework, a simulated crosswalk scenario was built using an Edge-AI LiDAR sensor communicating via a network switch with a laptop functioning as the RSU. Comprehensive network analysis of this setup quantified the bandwidth optimization achieved through the onboard Edge-AI processing (in comparison to processing raw LiDAR data). The culmination of this work is a custom Python interface that visualizes network metrics, captures raw sensor data, and runs local classification models, serving as a functional proof-of-concept for a highly efficient, infrastructure-enhanced V2X safety network.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Joy Roberts

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing Senior
(Sept. 2026):

Future Plans Graduate school/graduate school after some industry experience
(School/Career):

NIST Laboratory, Division, and Group: Communications Technology Laboratory, Wireless Networks Division, Wireless Systems Innovation and Performance Group

NIST Research Advisor: Dr. Wendy Guo

Title of Talk: Evaluating V2X Non-Terrestrial Network Performance Through Digital Simulation Tools

Abstract:

Vehicle-to-everything (V2X) communication is a technology that has broad potential applications for improving vehicle awareness of surrounding traffic and hazards. V2X enables vehicles to obtain and distribute safety-critical information. Vehicles with V2X capabilities broadcast and receive messages to determine the risk of collision and respond accordingly through warnings or automatic braking.

Current V2X communication is largely supported by terrestrial infrastructure like cellular base stations, road-side devices, and vehicles in near proximity. However, rural and underserved regions lack sufficient infrastructure to provide reliable V2X capacity. This project investigates the potential use of Low Earth Orbit (LEO) satellite networks as a complimentary mechanism to extend V2X network service. A satellite-to-vehicle communication model informed by 3GPP TR 38.811 was developed using MATLAB's Satellite Communications Toolbox. It permits adjustment to key parameters that allow link reliability, latency, and availability to vary across representative scenarios. Performance metrics are collected to assess the impact of each factor.

The model produces results evaluating link throughput, doppler shift, and path gains. This work provides an initial assessment of ideal satellite orbit and antenna characteristics that optimize V2X connectivity in areas with limited terrestrial network coverage. Generated data can inform satellite network providers, vehicle manufacturers, and standards organizations of system design choices best suited to a future with smart transportation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Jonathan Rich

Academic Institution: University of Maryland, College Park

Major: Computer Science

**Academic Standing
(Sept. 2026):** Junior

**Future Plans
(School/Career):** Plus 1 MS in cybersecurity, research or cyber analysis

**NIST Laboratory,
Division, and Group:** CTL, Wireless Networks Division, Wireless Systems Innovation and Performance Group

**NIST Research
Advisor:** Dr. Eugene Song

Title of Talk:
C-V2X Network Performance Assessment Tool

Abstract:

Vehicle-to-everything (V2X) communication is a wireless technology that enables vehicles to communicate with their surroundings, including other vehicles, traffic infrastructure, and pedestrians to improve safety and efficiency on the road. A major challenge with implementing V2X devices, however, is potential network performance issues. Ensuring network efficiency and reliability in multiple performance metrics, such as latency and packet delivery, is critical to V2X use cases. This is especially true for certain use cases such as emergency brake warnings and intersection collision warnings, which require consistently low latency and high reliability for keeping drivers and pedestrians safe.

For this project, an open-source software tool has been developed to assess performance of cellular V2X (C-V2X) networks and their devices, including both on-board units (OBUs) and roadside Units (RSUs). This tool utilizes the SAE J2735 and IEEE 1609.3 protocol standards to analyze given packet captures of V2X network activity, automatically assess network performance metrics based on V2X packet datasets, and produce a report of the network's performance analysis based on multiple performance metrics, including packet error rate (PER), packet end-to-end latency, inter-packet gap (IPG), and data throughput. To do this, the tool can access protocol fields by parsing the packet data from Packet Description Markup Language (PDML) files that are exported from Packet CAPture (PCAP) files collected in interoperability testing. By using protocol specific fields from transmitted packets, the tool can automatically match the received packets with corresponding transmitted packets, assess the performance metrics, and then visualize them. These metric visualizations are good indicators of V2X network performance, and contribute to the underlying goal of this tool, which is to serve as an open-source, easy-to-use solution for V2X network performance analysis.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Owen Lin

Academic Institution: University of Maryland

Major: Computer Science, Physics

Academic Standing
(Sept. 2026): Junior

Future Plans
(School/Career): Considering Phd in Physics or become software engineer

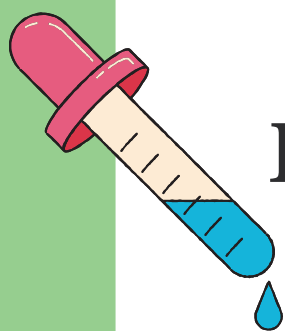
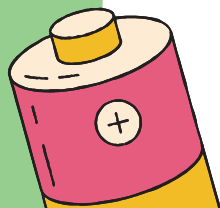
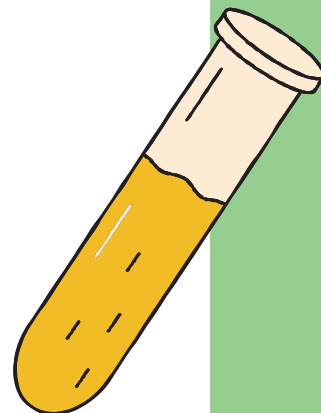
NIST Laboratory,
Division, and Group: CTL, Wireless Networks Division

NIST Research
Advisor: Anirudh Sahoo, Steve Blandino

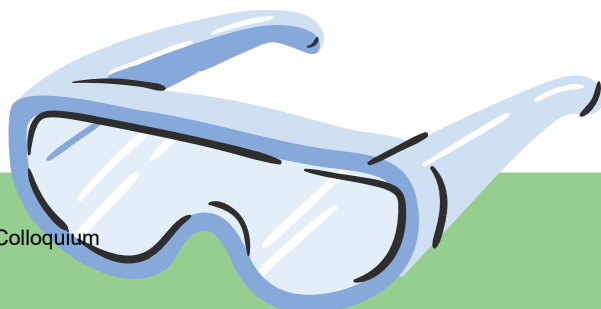
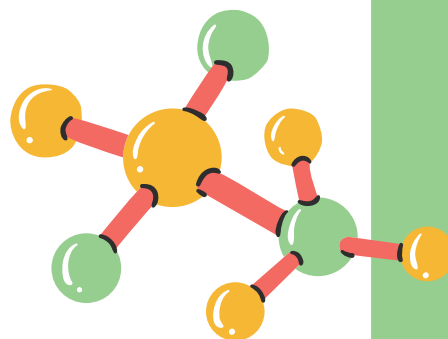
Title of Talk: Machine Learning Sensing Abstraction for ISAC System Level Simulation

Abstract: Integrated Sensing and Communications (ISAC) is an upcoming feature for the next generation 5G/6G cellular networks that will enable detection of physical objects and estimate their locations using the same communications hardware and spectrum. Evaluating system level performance of ISAC in 5G/6G networks requires high-fidelity simulations that models how radio waves propagate and scatter off objects. While these simulations are highly accurate, they are computationally intensive and very slow, making it impractical to evaluate sensing performance across large-scale network deployments.

This project proposes to develop a surrogate Machine Learning (ML) model that can predict ISAC sensing performance instantly, bypassing the need for full physics-based simulation. Given inputs such as the base station location, target position, and antenna array configuration, the model learns to estimate key performance indicators such as the probability of missed detection, the probability of false positives, and target position error. The ML model is trained on data generated from Monte Carlo simulations at the PHY layer with randomized geometry. The model is geometry agnostic and produces sensing performance comparable to the full-fledged PHY layer-based simulator.



Engineering Laboratory 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Engineering Laboratory (EL) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Dinah-Luba Beylison.(plenary.speaker).- Using Machine Learning to Enable Continuous Uncertainty Quantification of a Digital Twin for an Industrial Robot

Dawoon Jung - Curating and Encoding ML Asset Metadata into MLLO

Aditya Mishra - Vector Database and RAG Integration for Additive Manufacturing Terminologies

Mansour Mbow - Knowledge Maintenance in Additive Manufacturing: Leveraging MCP AI Agents for Shop Floor Data

Nimal Muthukumar - Mapping Machine Learning Metadata to the Machine Learning Lifecycle Ontology

Charles Bradshaw - Benchmarking the Performance of Mobile Manipulator End Effector Trajectories

McCarthy Devine - Development of Standard Test Artifacts and Hard Gaging Kits for the Dimensional Assessment of Internal Channels in Metal Additive Manufacturing

Alex Tamagno - Implementation of IEEE Standard for Robotic Task Representation in ARIAC

Michael Aladejebi - Temperature Effects on Reciprocity in 6-Port SPHERE

Emma Chang - Supporting the Material Flammability Database through Cone Calorimetry Data and Intermediate Scale Flame Spread Apparatus Development

Christopher Sixbey - Commissioning the Controlled Atmosphere Pyrolysis Apparatus (CAPA II)

Sabrina Rodriguez - Best Practices for Characterizing Thermal Radiation from Fires

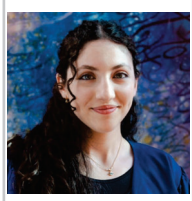
Edan Miller - Advancing Physical AL for Bimanual Pick-and-Place/Insertion Tasks via Imitation Learning from Teleoperation Data

Adithya Nair - Benchmarking Known-Object and Zero-Shot 6D Object Pose Estimation Frameworks for Precision Robotic Metrology

Ahikara Sandrasagra - Developing a Metric for Human-Exoskeleton Fit

Ilan Shapsay - Improving the Trustworthiness of a Deep Learning Model for Heart Health Monitoring

Arman Sagmanligil - Evaluating the Emissions of E-Scooter Fires



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Dinah-Luba Beylison

Academic Institution: Vanderbilt University

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Potential Masters Degree and Industry/Aerospace

NIST Laboratory, Division, and Group: Engineering Laboratory, Division 734 - Systems Integration Division

NIST Research Advisor: Guodong Shao, Rishabh Venketesh, Deogratias Kibira

Title of Talk: Using Machine Learning to Enable Continuous Uncertainty Quantification of a Digital Twin for an Industrial Robot

Abstract:

Digital twins (DTs) are becoming increasingly vital tools in manufacturing, with a wide variety of capabilities such as system monitoring, anomaly detection, performance prediction, process optimization, and system automation. To ensure these DTs are trustworthy and credible, Verification, Validation, and Uncertainty Quantification (VVUQ) must be implemented continuously throughout their lifecycle as the DTs and their physical counterparts evolve. This project focuses on Uncertainty Quantification (UQ) and continuously applies it to a DT of a collaborative robot. The objective of the DT is to perform anomaly detection on joint currents based on real-time robot position, velocity, and measured joint currents during pick-and-place activities. Continuous uncertainty quantification (UQ) enables probabilistic predictions that adapt to real-world system changes, providing confidence estimates that can better inform decision-making. Implementing continuous UQ in real time presents significant challenges because propagating uncertainties through complex physics-based simulations is computationally expensive. Machine learning offers a solution by learning surrogate models of the system behavior, enabling faster uncertainty quantification and propagation while significantly reducing computational cost and latency. The project is divided into two parts. First, I identified state-dependent uncertainty by training a machine learning model on data collected from the robot's different trajectories executed throughout the robot's work envelope. These trajectories also capture a broad range of velocities and accelerations, as well as hysteresis effects. This step is critical because uncertainty in robotic systems is often not constant, but varies as a function of the robot's operating state, defined by joint positions and motions. Second, I developed an uncertainty surrogate model trained on offline uncertainty propagation methods for efficient real-time uncertainty propagation. This surrogate replaces expensive repeated physics simulations at runtime, allowing near real-time uncertainty quantification throughout robot operation and enabling more trustworthy robotic DTs.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ambika Anand

Academic Institution: University of Maryland

Major:

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Graduate School

**NIST Laboratory,
Division, and Group:** Engineering Laboratory, Materials and Structural Systems Division

**NIST Research
Advisor:** Ashlee Aiello

Title of Talk: Characterization of Underfills for Reliable Semiconductors

Abstract:

Underfills are epoxy-resin based polymers that play a key role in the thermo-mechanical stability of advanced packaging for semiconductors. Cured underfills act as a rigid material to provide structural integrity to gaps between the substrate, dies and interconnects. As advancements in the semiconductor industry demand for miniaturization and vertical integration, large differences in the coefficient of thermal expansion between components has become a persistent challenge; packaging warpage, cracking and delamination reduce the operating lifetime of semiconductors and their derived products. To prevent such failures from occurring and promote more reliable semiconductors, thermal management has become a critical objective. To achieve this, optimization of underfills to enhance adhesion between substrate materials, die and solder is essential.

In this project, inverse gas chromatography was used to non-destructively measure underfill properties with molecular resolution under variable temperature and relative humidity. These capabilities allow for more powerful characterization of heterogeneous surfaces than normative contact angle methods. Capillary underfills were analyzed during curing and accelerated thermal aging to determine changes in surface energy and interfacial adhesion. These measurements will be provided to industrial partners to aid in developing predictive failure modeling, selecting and optimizing underfills, and reducing testing cost and time for the U.S semiconductor industry.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Natalia Quesada Marshall

Academic Institution: University of California, Berkeley

Major: Civil Engineering

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Pursue a PhD in Structural Engineering, Mechanics and Materials.

**NIST Laboratory,
Division, and Group:** Engineering Lab, Division 731, Infrastructure Materials Group

**NIST Research
Advisor:** Dr. Stephanie Watson

Title of Talk: Spectral Fingerprinting of Pyrrhotite Reactions in Concrete

Abstract:

Pyrrhotite is a naturally occurring iron sulfide mineral that is introduced into concrete through aggregates sourced from pyrrhotite-bearing rock and poses a severe threat to concrete infrastructure. When exposed to water and oxygen, pyrrhotite undergoes oxidation and subsequent internal sulfate attack, leading to volume expansion, spalling, and systemic structural failure. This has created a crisis in the Northeastern United States, with thousands of homes in Connecticut and Massachusetts already damaged and thousands more at risk. Despite updated building and DOT codes, the industry lacks standardized methods and concentration limits to accurately assess pyrrhotite abundance.

This project focuses on optimizing the analysis of pyrrhotite reaction products using Raman and Near-Infrared (NIR) spectroscopy to identify and quantify chemical species in aggregate and foundation specimens. Because pyrrhotite is relatively spectrally inactive, this study targets its deleterious secondary products: ferric oxyhydroxides via Raman, and gypsum and ettringite via NIR. By analyzing shifts in wavenumber and band intensity, changes in the chemical structure of the specimens can be inferred. Additionally, Raman microscopy is employed to examine the sealant-concrete interface and evaluate the ability of sealants to block moisture ingress and halt further reactions. By establishing these spectral signatures and optimizing spectrometer parameters, this work facilitates a more precise, consistent method for monitoring the chemical evolution of pyrrhotite-bearing concrete and developing reliable industry standards for mitigation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Evelyn Cabrera Hernandez

Academic Institution: Morgan State University

Major: Civil Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): B.S./M.S. in Civil Engineering

NIST Laboratory, Division, and Group: Engineering Laboratory, Division 731, Infrastructure Materials Group

NIST Research Advisor: Cody Strack

Title of Talk: Mitigating Pyrrhotite-Induced Concrete Damage Through the Application of Sealants and Coatings

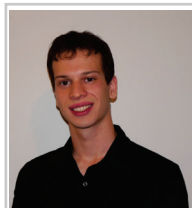
Abstract:

Concrete durability is strongly influenced by aggregate mineralogy. The iron sulfide pyrrhotite (Fe_{1-x}S) can undergo oxidation within the aggregate when exposed to moisture and oxygen, resulting in the formation of expansive reaction products. This process can lead to cracking in concrete foundations, which may eventually require costly removal. Surface-applied sealants and coatings offer a mitigation strategy by limiting moisture and oxygen transport, potentially extending the service life of existing structures.

This project investigates how treatment type and surface preparation influence sealant and coating behavior through a 14-specimen pilot study. Concrete pucks were prepared with untreated, mechanically treated (abrasion), or chemically treated (dilute phosphoric acid) surfaces before applying the three mitigation systems: silane, a penetrating sealer that reduces water ingress; lithium silicate, a densifier that modifies the near-surface pore structure; and a dual application of silane and epoxy, where epoxy functions as a protective coating. Treatment effects were assessed using multiple methods: measuring water absorption with a dropper, evaluating moisture ingress and penetration depth with a dyed indicator solution, and determining coating thickness via a wet-film gauge and dry-film ultrasonic measurements. Additionally, specimens were imaged with a stereoscope to document procedures and record visible changes during testing.

Additional characterization was performed on concrete extracted from pyrrhotite-bearing foundations in Connecticut using ASTM C1585 to measure water absorption and ASTM E96 to evaluate water vapor transmission. These performance tests provide insight into how mitigation treatments influence moisture transport in field-affected concrete and complement observations from the pilot study.

The results enhance the understanding of how different treatments alter concrete substrates and contribute to the establishment of procedures for future testing. Ultimately, this research aims to support practical



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Illai Faiman

Academic Institution: Montgomery College

Major: Civil Engineering

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Transfer to UMD, College Park to complete degree.

NIST Laboratory, Division, and Group: EL 731.07 Infrastructure Materials Group

NIST Research Advisor: Michael Mengason

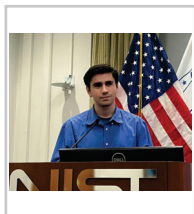
Title of Talk: Mapping Pyrrhotite-Driven Internal Sulfate Attack in Concrete Foundations with μ XRF

Abstract:

Deterioration of concrete foundations in homes in northeastern Connecticut has been linked to the presence of pyrrhotite-bearing aggregate. Pyrrhotite oxidizes on contact with water and air, initiating a series of expansive reactions that break down the concrete, termed “internal sulfate attack.” Damage from these reactions has brought many homes to the point of requiring a complete foundation replacement.

Cores were collected from residential buildings slated for foundation removal and replacement in the affected area. Of these cores, two were selected from one house: one of high visible damage and one of low visible damage. Division of the cores into inner, middle, and outer sample regions, followed by epoxy impregnation, forms solid samples in which aggregate, cement paste, and epoxy are all open to a smooth, testable surface.

In this project, Micro X-ray fluorescence spectrometry (μ XRF) is investigated as a tool for assessing the effect pyrrhotite has on concrete degradation. Epoxy contains chlorine, and elemental distribution maps of chlorine can be used to locate cracks in which epoxy has settled. Overlapping areas in sulfur and iron maps may indicate the presence of pyrrhotite, while sulfur and calcium may indicate the presence of sulfate minerals enabling us to locate enriched areas and reaction progression. Trends in these are examined within and between cores to evaluate whether elevated sulfate content is found surrounding pyrrhotite-bearing aggregate, equating to a noticeably higher amount of damage found in sulfate rich samples, of which most would be found in areas exposed to moisture and oxidation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Alexander Ibacache

Academic Institution: Virginia Tech

Major: Mechanical Engineering

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Pursue a master's degree

**NIST Laboratory,
Division, and Group:** EL, Division 731, IMG

**NIST Research
Advisor:** Patrick Dixon

Title of Talk: Expansion and Degradation of Two-Dimensional Configurations of Fused Quartz and Cement

Abstract:

Structural concrete foundations across Connecticut and Massachusetts are facing extensive deterioration, which has been attributed to aggregate containing pyrrhotite, a reactive iron sulfide mineral. While thousands of homes are currently affected or remain at risk, predicting this long-term degradation requires robust computational models validated by precise and controlled laboratory experiments.

This project leverages a mechanistic proxy, substituting pyrrhotite related expansion for the better characterized Alkali-Silica Reaction (ASR), which similarly creates internal expansive stresses that lead to cracking. To evaluate the degradation, simplified systems were developed using cubes consisting of two distinct two-dimensional geometric arrangements of fused quartz rods surrounded by cement. The fused quartz rods comprised approximately 9 % of the surface area and were arranged in two distinct configurations: globally ordered and locally disordered . Each configuration was cast with type I/II ordinary Portland cement with and without NaOH additions. The cubes were sawn perpendicular to the fused quartz rod direction into 3 sections of $7.46 \text{ mm} \pm 3.62 \text{ mm}$ thick sections. These sections were then subjected to an accelerating condition of 80 °C with a relative humidity of 75 % and an ambient control condition.

Microstructural degradation and cracking observations, along with expansion measurements from these sections, provide physical datasets for comparison to the 2D and 3D cracking models that NIST is currently developing. In addition, these results can be used as a reference for furthering computational modeling with simplified physical experimental data and the understanding of damage evolution caused by expansive forces within concrete.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Evan Taller

Academic Institution: The University of Alabama

Major: Mechanical Engineering

Academic Standing Junior
(Sept. 2025):

Future Plans Masters in Mechanical or Materials Engineering
(School/Career):

NIST Laboratory, Division, and Group: Engineering Laboratory, Division 731: Infrastructure Materials Group

NIST Research Advisor: Scott Jones and Irem Efe

Title of Talk: Investigating corrosion properties of steel reinforcements in concretes made with alternative cement formulations

Abstract:

Historically, ordinary portland cement (OPC) was used as the binder in reinforced concrete structures, which forms a stable, alkaline environment that favors the formation of a passive iron oxide film on the steel reinforcements, protecting them from corrosion caused by chloride from sources such as seawater or road salt. In recent years, the use of alternative cement formulations has increased due to the reduced environmental impact of production, as well as their promising properties for both conventional concrete and concrete 3D printing. However, the corrosion protection provided by these cements is not well studied

This project used electrochemical techniques to evaluate the effect of different cement formulations on passive film formation in three different cement types: portland limestone cement, ordinary portland cement, and calcium sulfoaluminate cement. Mirror-polished and as-received surface condition rebar samples were immersed in synthetic pore solutions. The samples were measured periodically with electrochemical techniques, specifically open circuit potential and potentiostatic electrochemical impedance measurements, to monitor the development of the passive film. In the second test, a set of as-received rebar samples were allowed to passivate in each of the three synthetic pore solutions for at least three weeks. The samples were then immersed in solutions with different concentrations of chlorides to determine the critical chloride content, C_{crit} , corresponding to the breakdown of the passive film and corrosion initiation. Potentiodynamic polarization tests were used to measure the readiness of the samples to pit and corrode in each solution.

This research improves the understanding of passive film formation and chloride-induced corrosion initiation in emerging low-carbon cement formulations, providing insight into the long-term durability and sustainability of reinforced concrete infrastructure.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Jessica Wang

Academic Institution: Duke University

Major: Environmental Sciences & Policy,

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Graduate School; Research career in environmental neuroscience

NIST Laboratory, Division, and Group: Engineering Laboratory, Materials and Structural Systems Division, Infrastructure Materials Group

NIST Research Advisor: Dr. Li-Piin Sung

Title of Talk: Photodegradation Mechanism Study of Polypropylene (PP)

Abstract:

Microplastics have become a pervasive environmental contaminant, with growing evidence linking their presence to ecological disruption. Polypropylene (PP) is among the most widely used plastics in consumer goods, food packaging, and fabrics, with over 84 million tons produced annually. However, in the United States alone, more than 2 billion pounds of PP are discarded every year, largely due to contamination and sorting difficulties during the recycling process. PP takes up to 40 years to physically break down, but it can never fully decompose; instead, it is photodegradable. Photodegradation, driven by UV exposure, combined with thermal and hydrolytic stress, is suspected to drive the fragmentation process and create microplastic particles. However, the specific mechanisms linking these environmental factors to particle formation, size distribution, and chemical transformation are not well established.

This study exposes PP samples to controlled combinations of UV radiation, temperature, and water using the NIST Simulated Photodegradation via High Energy Radiant Exposure (6-port SPHERE) facility to simulate realistic environmental aging. Exposed samples are characterized using Laser Scanning Confocal Microscopy (LSCM), Attenuated Total Reflectance Fourier-Transform Infrared (FTIR-ATR) spectroscopy, and Differential Scanning Calorimetry (DSC) to assess surface morphology, composition changes, and crystallinity over the course of degradation.

Through this research, we aim to clarify the mechanistic pathway from intact PP material to microplastic generation, and provide a methodological framework combining accelerated weathering with multimodal spectroscopy for assessing degradation in post-consumer PP.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Caleb Vu

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing

(Sept. 2025): Junior

Future Plans

(School/Career): Graduate school or going to the industry

NIST Laboratory,

Division, and Group: Engineering Laboratory, Division 731

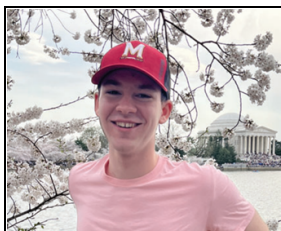
NIST Research

Advisor: Guangcui Yuan, Xiaohong Gu

Title of Talk: *Reliability Testing of an Underfill and a Thermal Interface Material for Advanced Packaging*

Abstract:

Modern design of microchips that include sensors, memory and CPUs all packaged into one single chip generates large amounts of heat during operation, which could decrease the device's performance and reliability. For an advanced package to maintain peak performance, heat must be actively dissipated from the chip to the heat sink, which is where underfills and TIMs (Thermal Interface Materials) come into play. Underfills absorb Coefficient of Thermal Expansion (CTE) mismatches to prevent solder joint fatigue, while TIMs minimize interfacial thermal resistance between heat sources and heatsinks ensuring effective heat dissipation. This project will study the fundamental thermal properties of a underfill and a TIM, as a part of the reliability analysis to understand their failure modes and thresholds. Specifically, accelerated environmental testing was conducted using temperature and humidity environmental chamber alongside Differential Scanning Calorimetry (DSC), Attenuated Total Reflectance (ATR) and Hot Disk Transient Plane Source (TPS) methods to quantify the aging effects of different environmental conditions on the underfill and the TIM.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Michael Donnelly

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): I plan to pursue a career in robotics.

NIST Laboratory, Division, and Group: Engineering Laboratory, Building Energy and Environment Division, HVAC&R Equipment Performance Group

NIST Research Advisor: Dr. Gregory Linteris

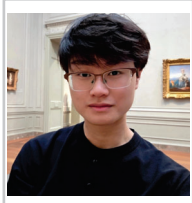
Title of Talk: Automating a Refrigerant Flammability Experiment

Abstract:

HVAC systems appear everywhere in people's lives. This can be in the form of air conditioning systems, refrigerators, heat pumps, and even many electronics. The working fluids that are used in them are undergoing a transition, and the new fluids will be flammable. This is new in the HVAC&R industry. Testing the flammability of the fluids that are required for these systems to operate is extremely important. An increase in this knowledge allows researchers to design safer systems for all sorts of use cases.

An existing experiment is designed to test the flammability of different refrigerant gases and gas mixtures.

This manual experiment is extremely tedious and requires attention and time. There are many places where mistakes can easily be made and require resetting the entire experiment. Automating the process allows for much better reliability, along with reducing time and energy being used to run the experiment. There is also an increase in the repeatability of the tests, as a person would no longer need to divert all of their time away from working on their other research if they wanted to run tests. The robotic system is able to run tests throughout the day, with built in data collection mechanisms. The entire process is controlled by Python, utilizing several different libraries, including the National Instruments library. This allows for straightforward connection to the Data Acquisition Devices. Python is also able to send and receive information to and from the relay systems, along with reading output signals from the pressure transducers. Altogether, the automated system allows for a large increase in efficiency and reliability compared to the previous design.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ethan Nee

Academic Institution: University of Maryland - College Park

Major: Aerospace Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): I plan to attend graduate school

NIST Laboratory, Division, and Group: Engineering Lab, Building Energy and Environment Div, HVAC&R Equipment Performance Group

NIST Research Advisor: Vance Payne

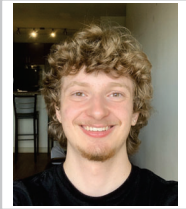
Title of Talk: Evaluating Dehumidifier Energy Standards Under Real-World Conditions

Abstract:

Portable dehumidifiers are a large market, with 1.8 million sold in 2020. The current energy conservation standards for dehumidifiers use tests performed at 65°F and 60% RH, with efficiency measured over 2 hours in liters per kilowatt-hour (L/kWh). However, in the majority of use cases, such as in a home's basement, conditions can differ from the standard test condition. Basements could plausibly be cooler, and dehumidifiers are typically set to dehumidify to lower humidities than standard conditions. These differences are hypothesized to lower efficiency. As such, the goal of this project is to test portable dehumidifier efficiency in real-world use cases and compare it against rated efficiencies.

This project entails creating small data loggers that can be attached to dehumidifiers in people's homes to gather real-world data. The data loggers are built from a Raspberry Pi and equipped with a condensate pump, load cell, wattmeter, and humidity and temperature sensors. The load cell measures condensate mass as it fills and automatically drains from the condensate pump. With these weight measurements and the known density of water, along with power data from the wattmeter and temperature and humidity data, efficiency over time can be calculated and plotted against humidity and dry bulb temperature.

Evaluation of this data may reveal shortcomings in current testing and standards, potentially leading to new testing conditions for portable dehumidifiers. This study could be a first step toward improving efficiency in the portable dehumidifier market.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Victor Mathias

Academic Institution: University of Maryland: College Park

Major: Aerospace Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Earn a master's degree in aerospace at UMD

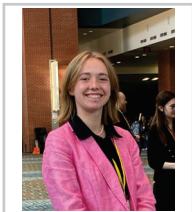
NIST Laboratory, Division, and Group: Engineering Laboratory, Division 732, Group 2

NIST Research Advisor: Glen Glaeser and Natascha Milesi Ferretti

Title of Talk: Validating a New Test Method for Pressure Loss in Modern Plumbing Fittings

Abstract:

Plumbing design in residential and commercial buildings continues to rely on sizing methods developed in the early 20th century, despite significant advances in pipe materials and fitting designs. As modern plumbing systems incorporate materials like CPVC, copper, and PEX, there is a pressing need for updated pressure loss data to allow for approaches that enhance both water efficiency and quality. This research focuses on the development and integration of a new experimental test rig to capture more detailed data on pressure loss in plumbing fittings. Using LabVIEW, the goal is to automate the hardware components for more efficient data collection. This includes programming solenoid valves to control fluid pathways, an RTD sensor to read temperature, a flow meter to analyze the exact flow rate, and a proportional Belimo valve for automated flow control. Work is also underway to calibrate pressure transducers to automate data measurements. Once these components are fully configured, they will be integrated into the physical assembly of the plumbing loop to begin data collection. Ultimately, this updated rig will provide the accurate data needed to modernize plumbing standards, lower construction costs, and support water conservation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Bri Grindrod

Academic Institution: CU Boulder

Major: Environmental Engineering

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Grad School

**NIST Laboratory,
Division, and Group:** Engineering Laboratory, Division 732, Group 3

**NIST Research
Advisor:** Tania Ullah

Title of Talk: Pressure Loss Testing of Modern Plumbing Fittings

Abstract:

Modern plumbing has come a long way since the invention of indoor toilets and sinks. As premise plumbing evolved, we have needed less and less volumes of water to do the same jobs, changing the type, structure and amount of plumbing needed within a building. Furthermore, the increased use of low-flow fixtures has dramatically reduced building water consumption, making the literature and design guidance on premise plumbing out of date. Modern pipe materials, such as plastics like PEX, have different qualities and connection mechanisms which change the pressure drop over different fittings. Using our custom-built automated rig, we are able to measure the static pressure both up and downstream of the fitting at various flow velocities (between 1 and 10 ft/s). This data is then used to calculate pressure drop, friction factors and surface roughness, all values which show us how material and fitting type affect water efficiency and performance within buildings. By qualifying these values, our research is not only able to update the design guidance on modern plumbing, but provide valuable data to the plumbing industry, and promote more efficient systems which can save consumers water, energy and money within homes and businesses.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Sania Manyem

Academic Institution: University of Maryland, College Park

Major: Information Systems and Economics

**Academic Standing
(Sept. 2025):** Freshman

**Future Plans
(School/Career):** BS in Information Systems and BS in Economics, MS in Data Science

**NIST Laboratory,
Division, and Group:** Engineering Laboratory, Division 732

**NIST Research
Advisor:** David Holmberg

Title of Talk: Semantic Interoperability for Cybersecurity in Buildings

Abstract:

Modern digital buildings rely on interconnected physical infrastructure, operational technology (OT), and information technology (IT) systems. While building ontologies such as ASHRAE 223 effectively model the physical assets, spaces, and equipment, they do not explicitly represent cybersecurity concepts or controls.

This project addresses the OT-IT gap in building security by developing a cybersecurity knowledge graph that integrates cybersecurity concepts into the existing ASHRAE 223 building model. This process includes analyzing the ASHRAE Standard 223 framework alongside the MITRE D3FEND ontology to identify cybersecurity concepts and relationships that are not represented in the building model. Missing concepts are incorporated through an RDF/OWL ontology extension that introduces new classes, properties, and relationships while maintaining compatibility with the existing ASHRAE 223 framework.

The resulting knowledge graph is validated using SHACL constraints and checked against SPARQL queries to ensure consistency with the intended ontology design. The consequent model promotes access controls and cybersecurity policy enforcement by integrating physical building infrastructure, OT devices, and cybersecurity controls within a unified framework. This project explores how semantic building models can serve as a foundation for cybersecurity analysis, risk assessment, and decision-making in digital buildings. The central research question guiding this project is: How can cybersecurity concepts be semantically integrated with ASHRAE 223 building models to create a knowledge graph for digital buildings, and what cybersecurity value does this provide for building operations?



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Philip Lee

Academic Institution: Purdue University

Major: Mechanical Engineering

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Graduate School or Industry

**NIST Laboratory,
Division, and Group:** Engineering Laboratory, Building Energy and Environment Division, Heat Transfer and Alternative Energy Systems Group

**NIST Research
Advisor:** Andrew Shore

Title of Talk: Modeling Photovoltaic Performance from Irradiance Database for Indoor Light Reference Spectra

Abstract:

Because of the increasing attention to Internet-of-Things (IoT) devices, there is a rise in interest for localized power sources to achieve net-zero energy ecosystems. One potential solution is indoor photovoltaics (PV), but it lacks standardized metrology for artificial lighting. There is a need for precise physical calibration standards, reference indoor lighting spectra, and performance metrics from measured data; this creates a bridge between metrology and real-world application that is essential to validating indoor PV as a viable power source for IoT devices. This project works toward that goal by modeling indoor PV behavior from measured data via current-voltage (IV) curves and calculating daily energy yield, maximum power, and power conversion efficiency to quantify PV viability. Indoor spectral irradiance data was captured every 10 minutes from 3 different locations of the living room at the Residential Test Facility (RTF), capturing how the irradiance changes spatially and over time. This data was then paired with the spectral responsivity of an organic PV module, measured using the differential spectral response (DSR) method, along with its IV curve measured under a reference condition of 1000 lux with a 3K CCT LED. Integrating the spectral responsivity with the irradiance data provides the short circuit current for each spectrum. This is then used to fit the double diode circuit model to the measured IV curve, allowing us to project the theoretical IV performance under the measured lighting conditions. However, the double diode model is implicit, so we applied a global optimization to fit model parameters to the cell's reference IV curve. These parameters are then used to solve for an IV curve and maximum power for each spectrum in the irradiance dataset. These calculations provide an example of energy harvesting potential, supporting the broader goal of self-sufficient IoT devices.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Anna Linteris

Academic Institution: Case Western Reserve University

Major: Electrical Engineering

Academic Standing Sophomore
(Sept. 2025):

Future Plans Pursue graduate degree or go into the industry.
(School/Career):

NIST Laboratory, Engineering Laboratory, Building Energy and Environment Division, Heat Transfer and
Division, and Group: Alternative Energy Systems Group

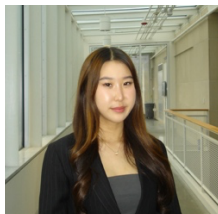
NIST Research Dr. Theresa Ginley
Advisor:

Title of Talk: Characterizing Defects within Silicon Carbide Semiconductors through Hyperspectral
Ultraviolet Photoluminescence Spectroscopy

Abstract:

The ever-increasing power demands of modern society are outpacing the capabilities of traditional silicon-based semiconductor technologies. To address this deficiency, industry leaders are turning to a new class of power electronic materials called wide bandgap semiconductors which can handle substantial power loads with superior transfer efficiency. Silicon carbide (SiC) specifically has emerged as a leader due to its high thermal conductivity and breakdown voltage, allowing it to operate more efficiently and within more advanced applications than its predecessors. However, SiC is prone to crystal defects that lead to reduced performance and reliability. To understand how such defects arise and could influence power electronic devices, it is critical to characterize various defect types in SiC wafers prior to device fabrication.

In this study, hyperspectral ultraviolet photoluminescence (UVPL) spectroscopy is used to characterize defects within SiC. This non-destructive experimental technique allows us to capture a full PL spectrum at each image pixel after excitation at sub-micron resolution. Many defect types have characteristic PL signatures such as changes in emission amplitude or frequency. By using a multi-gaussian fit to distinguish the different characteristic emission lines from each other, these key features can be mapped out across the entire scanned area to provide insight into defects. This is particularly helpful to examine defects with small signatures that would otherwise be overshadowed by the background PL emission. When other techniques including atomic force microscopy and electron channeling contrast imaging are used alongside UVPL, previously missed information such as defect location at an atomic level can be collected, correlated, and used to further evaluate specific defects within SiC samples. These approaches will result in an improved understanding and precise identification of defects, providing insight into material properties. This knowledge will ultimately allow for optimized fabrication of SiC for mainstream development.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Dawoon Jung

Academic Institution: Cornell University

Major: Electrical & Computer Engineering

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Pursuing a career in Engineering; U.S. Army Reserve officer

NIST Laboratory, Division, and Group: Engineering Laboratory, Systems Integration Division

NIST Research Advisor: Boonserm Kulvatunyou

Title of Talk: Curating and Encoding ML Asset Metadata into MLLO

Abstract:

Machine learning datasets and models are often created across different platforms, and each platform stores metadata in a different format. This makes it difficult to trace how an ML asset was produced, what data it depends on, and whether it can be reused in another setting. This project addresses that issue by curating public ML artifact metadata and encoding it into the Machine Learning Lifecycle Ontology (MLLO), a formal ontology for representing machine learning assets across the ML lifecycle.

The project began by manually recreating an MNIST example in Protégé to understand how MLLO represents classes, individuals, and relationships. The resulting ontology artifact was exported and uploaded to Moby and GraphDB as a test encoding. After this initial example, public dataset and model repositories were reviewed, including Kaggle, UCI, Hugging Face, Papers with Code, MedMNIST, and Therapeutics Data Commons. Candidate assets were selected across drug discovery, medical imaging, and clinical healthcare, with five MLLO model categories targeted: ArtificialNeuralNetwork, NonParametricModel, PolynomialModel, ClusteringModel, and DimensionalityReductionModel.

For each asset, metadata related to dataset characteristics, preprocessing, model type, training configuration, input assumptions, and performance metrics was encoded as OWL individuals and object property assertions in Protégé. Current work focuses on BreastMNIST, using MedMNIST download data and existing MLLO examples to map medical imaging assets into the ontology. The encoded metadata is loaded into GraphDB and tested with SPARQL queries.

This workflow supports structured ML metadata extraction while also identifying MLLO gaps related to imaging modalities, noise types, and model input assumptions. These gaps inform a revision proposal and updated ontology draft for future encoding.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Aditya Mishra

Academic Institution: University of Maryland College Park

Major: Mechanical Engineering

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Engineering Industry/Graduate School

**NIST Laboratory,
Division, and Group:** Engineering Laboratory, Division 734

**NIST Research
Advisor:** Shengyen Li

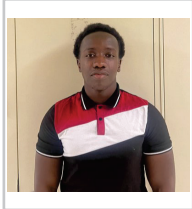
Title of Talk: Vector Database and RAG integration for Additive Manufacturing Terminologies

Abstract:

NIST is leading the development of AI tools for various Additive Manufacturing (AM) processes that can benefit from AI autonomy; examples include the NIST-built laser powder bed fusion test bed and other commercial AM fabrication farms consisting of various types of 3D printers. To integrate powerful, accurate models and software tools that retrieve domain-specific knowledge, a string vector database is required.

This initiative project examined various domestic embedding models for populating a vector database from pre-processed data. We surveyed 5 open-source models and compared them based on input token size, embedding length, model architecture, and the overall size required to host the model. After the various similarity comparisons, we chose an appropriate model that runs on our AI software of choice.

The AI software integrates our embedding models and populated vector databases with a Large Language Model (LLM) that performs Retrieval-Augmented Generation (RAG) operations to answer user questions, with sources and citations. Different software packages have varying levels of access to the backend. An ideal platform gives us control over the vector database and other operations, allowing us to tweak settings to best suit additive manufacturing practices. This project initiated the development of a vector database integrated with a chosen software platform that can be used on an AM shop floor to assist decision-making.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Mansour Mbow

Academic Institution: University of Maryland

Major: Computer Engineering

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): My goal is to continue my education in Computer Engineering and AI through graduate school, earn a Ph.D., and eventually attend law school.

NIST Laboratory, Division, and Group: Engineering Laboratory: 734.12

NIST Research Advisor: Lisha White

Title of Talk: Knowledge Maintenance in Additive Manufacturing: Leveraging MCP AI Agents for Shop-Floor Data

Abstract:

Additive Manufacturing (AM) generates vast amounts of raw lifecycle and sensor data, often stored in specialized formats like HDF5. While this "Big AM Data" has the potential to significantly improve product quality, it generally lacks the domain-specific context required for complex analysis and decision-making. Knowledge graphs and formal semantics offer a viable solution by structuring relations between domain concepts to enable reasoning, but manually maintaining these graphs remains a major logistical challenge.

To address this maintenance hurdle, this work proposes a proof-of-concept pipeline that leverages Large Language Models (LLMs) alongside the Model Context Protocol (MCP). The pipeline automates knowledge graph updates without human intervention through three core units: Knowledge Query, Data Extraction, and Automatic Knowledge Maintenance. The Knowledge Query Unit allows LLMs to interact directly with the existing knowledge graph to search, verify and trace the schema. To interface with the raw AM data, the Data Extraction Unit consists of an approach for the LLM to read low-level machine metadata and retrieve the appropriate data from a file source. Finally, the Automatic Knowledge Maintenance Unit provides a mechanism to automatically trigger and update the knowledge graph based on data extracted from the HDF5. Utilizing these core units the pipeline demonstrates how the LLM-MCP paradigm can continuously maintain AM knowledge for downstream decision-making.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Nimal Muthukumar

Academic Institution: University of Maryland, College Park

Major: Computer Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): I plan on working at a technology company as an embedded software engineer and obtain a masters degree in either business administration or engineering.

NIST Laboratory, Division, and Group: Engineering Lab, Systems Integration Division, Process Engineering Group

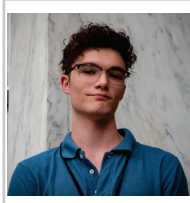
NIST Research Advisor: Boonserm Kulvatunyou

Title of Talk: Mapping Machine Learning Metadata to the Machine Learning Lifecycle Ontology

Abstract:

Machine learning (ML) pipelines are developed with various frameworks, storing important metadata including model architecture, optimizers, hyperparameters, and other metadata in their respective framework specific formats. These hinder understandability, explainability, and reuse of the pipeline and its underlying entities such as datasets, data preprocessing, and machine learning models. NIST has developed a draft standard, called Machine Learning Lifecycle Ontology (MLLO), for representing pipeline data so that ML pipelines can be better reused, leading to improving ML development and deployment. A tool for pipeline data extraction from the TensorFlow framework has also been developed as part of the MLLO validation. This project extended that tool to validate MLLO against two other frameworks, namely PyTorch and Scikit-Learn.

Building off of these frameworks, the presentation will introduce the Machine Learning Lifecycle Ontology (MLLO) and the challenge of extracting consistent metadata amongst different machine learning frameworks. It will further elaborate on how the current TensorFlow metadata extraction tool was successfully extended to the other Scikit-learn and PyTorch frameworks and how the metadata of each were also mapped to a common ontology based-representation. Furthermore, the presentation will demonstrate the validation of the frameworks using representative MedMNIST models and discuss how MLLO is able to improve the interoperability and reusability of machine learning pipelines between multiple frameworks. Ultimately, this work demonstrates the feasibility of standardizing machine learning metadata across diverse frameworks, supporting more machine learning workflows.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Charles Bradshaw

Academic Institution: Salisbury University

Major: Computer Science & Data Science

Academic Standing Junior

(Sept. 2025):

Future Plans (School/Career): I plan to attend grad school for a master's degree in computer science, and then pursue a career in robotics.

NIST Laboratory, Division, and Group: Engineering Laboratory, Intelligent Systems Division, Sensing and Perception Systems

NIST Research Advisor: Omar Aboul-Enein

Title of Talk: Benchmarking the Performance of Mobile Manipulator End Effector Trajectories

Abstract:

Mobile manipulators, systems that combine a mobile base and a robotic arm, leverage their combined efficiency and precision to perform a variety of discrete pose tasks like pick-and-place and drilling, as well as continuous trajectory tasks such as welding, sanding, and even concrete 3D printing. When performing at their optimal level, mobile manipulators have the potential to revolutionize workflows, but only if they can meet the stringent tolerances required for precision tasks. Performance uncertainty, which can be caused by the effect of environmental conditions, imprecise localization, or wear over time could lead to tasks being done improperly, which hinders adoption of mobile manipulators by industry. As such, methods of performance validation are incredibly important. To address this need the National Institute of Standards and Technology have developed several mobile manipulator performance measurement tests and artifacts. However, previous work has not considered continuous trajectory tasks, limiting evaluation of important performance metrics.

This project proposes a modular, cost-effective, and accessible design for performance measurement of mobile manipulator trajectory following. This was achieved by designing a modular system of reflective target tracks, which can model a given trajectory in a two-dimensional coordinate plane with variable tolerances. A retroreflective laser sensor mounted to the manipulator's tool flange allows for pass/fail trajectory following assessment. In addition, a graphical tool to generate trajectories down to the millimeter via an interactive plot was developed to simplify path planning. This system allows users to test if their mobile manipulator is able to meet the requirements of their desired task, as well as identifying potential trouble zones in the trajectory such as sharp turns. Eventual evolution of this design into a standard test practice will allow for trajectory validation as well as efficiency tuning and manipulator evaluation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: McCarthy Devine

Academic Institution: University of Colorado Boulder

Major: Aerospace Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Pursue master's and career in aircraft design

NIST Laboratory, Division, and Group: Engineering Laboratory, Intelligent Systems Division, Production Systems Group

NIST Research Advisor: Jesse Redford

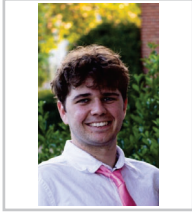
Title of Talk: Development of Standard Test Artifacts and Hard Gaging Kits for the Dimensional Assessment of Internal Channels in Metal Additive Manufacturing

Abstract:

Additive Manufacturing (AM) is a production method that prints metal components layer-by-layer. One aspect that makes AM unique is the ability to produce complex components with curved internal channels that would be impossible to produce with traditional subtractive machining processes. The goal of my project this summer was to develop new standard test artifacts and inspection procedures to determine the achievable dimensional tolerances of internal channels produced by laser powder bed fusion and other metal AM processes.

Three artifacts were designed to evaluate manufacturing capabilities across varying levels of geometric complexity. Each artifact features five channels with diameters ranging from 2 mm to 10 mm. The first artifact evaluates straight channels printed at various build angles; the second introduces a 180-degree vertical bend; and the third incorporates two vertical turns and a horizontal spiral. One objective is to determine if the worst dimensional performance observed across the different build angles in the straight channel artifact correlates with the performance on the more complex artifacts.

To inspect these artifacts, a specialized hard gaging system was developed based on existing and closely related standards. This included the design and implementation of a customized GO/NO-GO ball gage kit. In collaboration with US manufacturing companies, channel dimensions and tolerance ranges were established to ensure industrial relevance of the test artifacts. This research and development effort provides a first step towards new manufacturing standards for the dimensional assessment of internal channels in metal additive manufacturing.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Alex Tamagno

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Pursue a masters in computer science after graduating.

NIST Laboratory, Division, and Group: Engineering Laboratory, Intelligent Systems Division, Cognition and Collaboration Systems Group

NIST Research Advisor: Justin Albrecht

Title of Talk: Implementation of IEEE standard for Robotic Task Representation in ARIAC

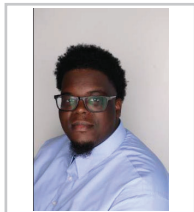
Abstract:

The Agile Robotics for Industrial Automation Competition (ARIAC) is an annual challenge that requires participants to develop simulation software capable of controlling robots in dynamic industrial environments. These simulations mirror real-world factory operations, necessitating the precise execution of tasks such as item retrieval, assembly, and packaging.

For this project, I implemented the IEEE Standard for Robot Task Representation (IEEE Std. 1872.1-2024) to determine if a standardized hierarchical approach could improve the reliability of the robot's performance. A core value of this standard is the decomposition of robotic operations into a hierarchy. Complex operations are defined as "composite tasks," which are further subdivided into "atomic tasks" which are the most basic units of action that the robot can execute.

To implement this standard, I mapped the competition's requirements into this structured format. For example, the objective of retrieving a cell from a moving conveyor belt was modeled as a composite task. This complex goal was then decomposed into a sequence of atomic tasks, including moving the robot picking the cell to its required configurations as well as having the robot grab the cell and place the cell in the voltage tester.

The application of IEEE Std. 1872.1-2024 to the ARIAC environment served two primary purposes. First, it allowed for an evaluation of the standard's versatility when applied to rigorous, time-sensitive industrial simulations. Second, it highlighted the challenges in mapping abstract standards to concrete physical movements. Ultimately, this project demonstrated that utilizing the IEEE standard as a structural blueprint not only streamlines the development process for complex robotic workflows but also ensures a level of clarity crucial for industrial automation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Michael Aladejebi

Academic Institution: Towson University

Major: Applied Physics

**Academic Standing
(Sept. 2025):** Senior

**Future Plans
(School/Career):** Nuclear Physics

**NIST Laboratory,
Division, and Group:** Engineering Laboratory 731.08

**NIST Research
Advisor:** Karrisa Jensen

Title of Talk: Temperature Effects on Reciprocity in 6-Port SPHERE

Abstract:

Polymeric materials used in outdoor environments are continuously exposed to ultraviolet (UV) radiation, elevated temperatures, and moisture, leading to chemical and physical degradation that limits their service life. Developing reliable accelerated weathering methods and improving service life prediction models are major research efforts at the National Institute of Standards and Technology (NIST). This project uses polyethylene terephthalate (PET) film as a model material to evaluate the adherence of the NIST 6-Port Simulated Photodegradation via High Energy Radiant Exposure (SPHERE) to the reciprocity law. Reciprocity assumes that equivalent UV doses produce equivalent material degradation regardless of the irradiance or exposure duration, making it a fundamental principle of accelerated weathering. In this study, PET films are exposed in the NIST 6-Port SPHERE under 50°C and 85°C with 0% relative humidity. Neutral density filters measured to be approximately 40%, 70% and 100% transmittance are used to vary the irradiance, creating multiple exposure conditions. Material degradation is characterized using Fourier-transform infrared spectroscopy (FTIR) to evaluate chemical degradation, UV-Visible spectroscopy to characterize optical changes, color and gloss measurements to quantify surface appearance, and confocal microscopy to assess surface morphology. The results of this study are expected to provide new insight into how well the NIST 6-Port SPHERE follows the reciprocity law under different thermal conditions at low relative humidity. By relating equivalent UV doses to measured material degradation, this work will help determine how confidently accelerated weathering data generated using the 6-Port SPHERE can be used to predict outdoor performance, supporting improved service life prediction models and more reliable polymer durability testing.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Emma Chang

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Junior/3rd Year

Future Plans (School/Career): Graduate Degree

NIST Laboratory, Division, and Group: Engineering Laboratory, Fire Research Division, 733, Flammability Reduction Group (FRG)

NIST Research Advisor: Isaac Leventon

Title of Talk: Supporting the Material Flammability Database through Cone Calorimetry Data and Intermediate Scale Flame Spread Apparatus Development

Abstract:

Predictive fire models rely on accurate material property data to simulate ignition, burning behavior, and fire spread across many different fire scenarios. To support the development and validation of the Fire Dynamics Simulator (FDS), the National Institute of Standards and Technology (NIST) is developing the Material Flammability Database (MFD), which is a repository of experimentally derived material properties and validation datasets. My project contributes to the development of the MFD by providing bench-scale flammability data using a cone calorimeter, while supporting the development of an intermediate-scale apparatus for model validation. Together, both parts of this project strengthen the connection between laboratory material characterization and fire behavior predictions.

Bench-scale testing performed by the cone calorimeter characterizes material flammability and provides data for the MFD. Experimental responsibilities include apparatus calibration, running tests on select materials, and troubleshooting different sources of measurement uncertainty, including C-factor and load-cell drift, to ensure accurate and repeatable data. My work also supports the redesign and implementation of an Intermediate Scale Flame Spread (ISFS) apparatus, which is being modified to determine the radiant heat flux absorbed into burning materials. Contributions include the mechanical design and installation of various apparatus components, the development of air-cooled camera systems, calibration of heat flux gauges, and general apparatus planning. The combination of bench-scale testing and intermediate-scale validation advances the ability of the FDS to better predict fire behavior and flame spread scenarios.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Christopher Sixbey

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Accepting an engineering position within the federal government

NIST Laboratory, Division, and Group: Engineering Lab, Fire Research Division (733), Flammability Reduction Group

NIST Research Advisor: Dr. Isaac Leventon

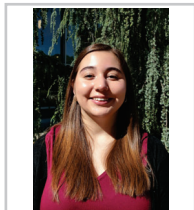
Title of Talk: Commissioning the Controlled Atmosphere Pyrolysis Apparatus (CAPA II)

Abstract:

Pyrolysis, defined as the thermal decomposition of materials, is a crucial aspect within the field of fire research. A key characteristic of pyrolysis is the production of volatile gases, liquids, and solids as a certain material decomposes during heating. Since this decomposition often produces flammable vapors that can ignite, the study of pyrolysis can give fire researchers powerful predictive insight into flame dynamics and fire growth. Such insight is valuable in developing new fire growth models, creating measures to combat flame spread, and formulating modern safety systems that can save lives. To this end, my current project focuses primarily on the commissioning of an improved bench scale flammability testing device: the Controlled Atmosphere Pyrolysis Apparatus (CAPA II). CAPA II will be used to conduct calibration (property development) and validation experiments for the development of the NIST Material Flammability Database (MFD), a unified collection of predictive fire growth models.

The design of CAPA II allows for a convenient method of measuring the effects of pyrolysis and other burning behaviors of intumescent materials. As a material sample burns under controlled, uniform radiative heating, this apparatus will be used to measure properties such as temperature distribution, sample mass loss rate, shape changes, and exhaust content. Design elements that allow for these measurements to be taken include a sample chamber with internal water cooling channels, a spark ignition system, a water-cooled balance, air-cooled cameras, and a nitrogen-air mixer for burning under different atmospheric conditions.

Last summer, I focused on the preliminary installation of CAPA II's water cooling lines, nitrogen plumbing, and electrical and data acquisition systems. This summer, my focus shifts to finalizing data acquisition elements such as heat flux gauges and cameras, optimizing water cooling, and setting up software for CAPA II's commissioning and initial calibration. As a secondary responsibility, I will also be aiding with the optimization and setup of another apparatus, the Intermediate Scale Flame Spread apparatus (ISFS), for the purpose of conducting larger scale fire experiments at the end of the summer.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Sabrina Rodriguez

Academic Institution: Bradley University

Major: Mechanical Engineering

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Attend Graduate School

**NIST Laboratory,
Division, and Group:** Engineering, Fire Research, NFRL (733.06)

**NIST Research
Advisor:** Rodney Bryant

Title of Talk: Best Practices for Characterizing Thermal Radiation from Fires

Abstract:

Thermal radiation emitted by fire plays a critical role in understanding the mechanics of how a fire spreads through a room or building. For large-scale fires, thermal radiation is the dominant mode of heat transfer to surrounding objects, causing them to thermally decompose and release fuel vapor that can potentially ignite. Accurate characterization of thermal radiation from fires is therefore important for predicting fire spread, and for assessing risks to surrounding materials and infrastructure. Heat flux gauges are commonly used to measure the thermal radiation emitted from fires. However, the measurements are limited in their usefulness without effective deployment. Experiments were conducted in the National Fire Research Laboratory (NFRL) to better understand the limitations and challenges of deploying heat flux gauges in fire experiments. Heat flux gauges were exposed to natural gas fires with step increases in heat release from 50kW to 300kW. Gauge temperature was monitored to characterize the impact of gauge cooling/heating on measurement drift. Heat release due to thermal radiation was calculated and used to observe the drift in the gauge readings. Smaller scale tests will be run to characterize the angular response of the gauges by rotating the gauge relative to a steady flame. Characterizing angular response will be useful for decisions on gauge positioning and interpreting gauge response.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Edan Miller

Academic Institution: University of Maryland - College Park

Major: Electrical Engineering & Geography

Academic Standing (Sept. 2025): Junior (both majors)

Future Plans (School/Career): I wish to continue my education (PhD) and eventually work on the intersection of robotics, AI, and disaster response.

NIST Laboratory, Division, and Group: Engineering Laboratory, Intelligent Systems Division

NIST Research Advisor: Yong Sik Kim

Title of Talk: Advancing Physical AI for Bimanual Pick-and-Place/Insertion Tasks via Imitation Learning from Teleoperation Data

Abstract:

With the recent surge in the integration of AI into mechanical systems, we have seen incredible potential to revolutionize automation and execute complex manipulations. Primarily, physical AI has been incorporated into automation-dominated single-arm systems; however, these configurations are not without their limitations. Mimicking human dexterity, dual-arm coordination can fill these gaps by performing complex tasks that are inherently difficult or impossible for a single limb, while also allowing robots to integrate into existing workspaces with minimal infrastructure modifications.

This project examines the use of LeRobot SO-ARM 101 models in foundational teleoperation testing and the creation of robust pick-and-place/insertion task episodes for use with imitation learning frameworks such as ACT and Diffusion Policy. These findings are intended to update the current baseline of performance evaluation metrics NIST provides to the public and bolster applications in larger industry-standard arms like the UR10 in bimanual contexts, furthering American enterprise and maintaining force control measures that ensure user safety.



SURF Student Colloquium

NIST – Gaithersburg,
MD August 3-6, 2026

Name: Adithya Nair

Academic Institution: Virginia Tech

Major: Systems and Computer Engineering

Academic Standing (Sept. 2026): Senior

**Future Plans
(School/Career):** Computer Vision / Spatial Computing Engineer

**NIST Laboratory,
Division, and Group:** Sensing and Perceptions Systems Lab (EL), Division 735, Intelligent Systems Division

NIST Research Advisor: Mr. Prem Rachakonda

Title of Talk: Benchmarking Known-Object and Zero-Shot 6D Object Pose Estimation Frameworks for Precision Robotic Metrology

Abstract:

Six degrees of freedom (6DOF) object pose estimation is a critical capability for enabling autonomous robotic systems to precisely grasp, manipulate, and measure objects in automated metrology workcells. This project provides a comprehensive literature review and the practical deployment of multiple state-of-the-art, open-source pose estimation algorithms to evaluate their viability for integration with industrial 3D sensors and robotic systems. The project systematically evaluates the 6D pose estimation algorithms tracking the architectural evolution from rigid, object-specific models, such as the Dense Pose Object Detector (DPOD) and CosyPose, to highly generalized, zero-shot tracking solutions such as Any6D and FoundationPose capable of operating on novel/unseen items.

These algorithms use raw sensor frames to compute absolute rotation matrices and translation vectors relative to the sensor frame. To rigorously evaluate model performance under severe occlusions and structural symmetries, pose predictions are benchmarked using formal metrics such as Visual Surface Discrepancy (VSD), Max Symmetry Surface Distance (MSSD), and Max Projection Distance (MSPD).

This benchmarking provides actionable insights for optimizing robust spatial awareness of a robotic system and deploying generalized object tracking and path planning routines within physical manufacturing environments.



SURF Student Colloquium

NIST – Gaithersburg, MD August

3-6, 2026

Name: Ahikara Sandrasagra

Academic Institution: Cooper Union

Major: Electrical Engineering

Academic Standing Sophomore
(Sept. 2025):

Future Plans Potential graduate school, possible career in industry, academia, or govt related to
(School/Career): engineering/math

NIST Laboratory, EL 735.11
Division, and Group:

NIST Research Benjamin Beiter
Advisor:

Title of Talk: Developing a Metric for Human-Exoskeleton Fit

Abstract:

Proper human-exoskeleton fit is important for user safety and comfort. Effective fit also facilitates better robotic assistance with movements and tasks. The evaluation of fit has previously been based upon subjective user feedback and high-cost laboratory measurements, leading to a lack of consistent and low-cost testing methods. Human-exoskeleton fit has also not generally been quantified in a way that allows for precise evaluation. This project focuses on a framework to develop and evaluate human-exoskeleton fit metrics through two phases, with the goal of improving exoskeleton user experiences.

The first phase consists of collecting high-quality data using a marker-based optical tracking system (OTS), inertial measurement units (IMUs), and a marker-less, multi-camera motion capture system. A MATLAB pipeline processes data and computes fit metrics as informed by a literature review on the subject. Metrics include translational axis drift, static anthropomorphic alignment offset, and axis intersection angle skew.

The second phase consists of developing an accessible, low-cost computer vision algorithm using Python, OpenCV (for marker annotations), YOLOv8 (for object detection), and MediaPipe/BlazePose (for human skeletal tracking). This video-based pipeline supplements the tracking outputs of the lab motion-capture techniques, while also allowing for both real-time and pre-recorded video inputs.

The data collected from the second-phase low-cost computer vision algorithm will be quantitatively compared to the first-phase metric analysis and results. By directly evaluating the tracking error and metric reliability of an accessible video process against a high-cost laboratory baseline, this work provides a roadmap for deploying cost-effective and reliable exoskeleton fit assessment tools.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ilan Shapsay

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing

(Sept. 2025): Junior

Plans

(School/Career): Work in Industry then Graduate School

NIST Laboratory,

Division, and Group: EL, Fire Fighter Technology Group

NIST Research

Advisor: Dr. Wai Cheong Tam

Title of Talk: Improving the Trustworthiness of a Deep Learning Model for Heart Health Monitoring

Abstract:

Sudden Cardiac Death (SCD) remains the leading cause of firefighter-related death in the United States, consistently encompassing around 40% [1] of firefighter fatalities from 1990 to 2024 [2]. Therefore, an early-warning device is being developed to alert firefighters to impending heart attacks, preventing them from minimizing their symptoms by differentiating between malaise and a medical emergency. The device pairs an elastic chest band holding a single electrode that generates real-time EKGs with a CNN BiLSTM model – nicknamed ‘H2M’ – to detect abnormal heart beats and provide a secondary opinion on heart attack likelihood based on abnormal heartbeat frequency.

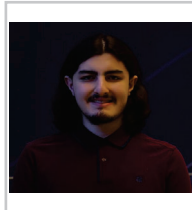
My contribution focuses on exploring interpretability and data augmentation to improve the H2M model’s performance and trustworthiness. To ensure the H2M model identifies the correct waves and smaller structures in its detection, my work focused on narrowing down, exploring, and adapting attribution methods to understand the relative importance of areas within an EKG segment that drive the H2M model’s classifications.

I evaluated five methods - Integrated Gradients, Guided Grad CAM, Occlusion, Ablation Testing, and Counterfactual Generation – to search for consistency among their saliency maps and investigate unexpected attribution scores. My results added robustness to the H2M model’s predictions by finding that the model focuses on the time intervals between R-peaks and missing P-waves for supraventricular beats (SVPBs) and distorted QRS complexes for ventricular premature beats (VPBs). However, I also identified H2M’s vulnerability to noisy and high amplitude EKG signals, caused by jumping or panting, as a byproduct of over-filtering noise from the training data.

Applying several Python scripts designed to modify and manipulate EKG signals for ablation testing, I am working to address these shortcomings. By combining augmented structures from various EKGs, I am introducing more noisy EKG data into the H2M model’s training dataset to improve its performance and decrease its misclassification frequency in continuous monitoring.

[1] Li, J.; Brown, C. U.; Dzikowicz, D. J.; Carey, M. G.; Tam, W. C.; Huang, M.X. Towards Real-Time Heart Health Monitoring in Firefighting Using Convolutional Neural Networks. *Fire Safety Journal* **2023**, *140*, 103852–103852, doi:<https://doi.org/10.1016/j.firesaf.2023.103852>.

[2] U.S. Fire Administration Statistics. Available online: <https://www.usfa.fema.gov/statistics/>.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Arman Turker Sagmanligil

Academic Institution: University of Maryland College Park

Major: Chemical and Biomolecular Engineering

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Seeking a Masters in Systems Engineering at University of Maryland College Park

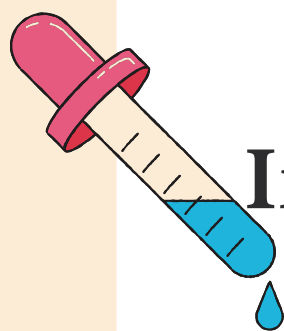
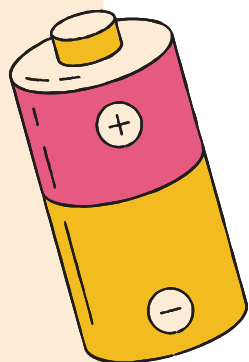
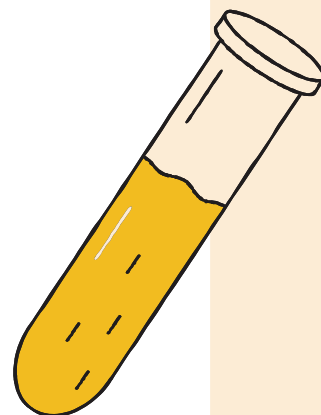
NIST Laboratory, Division, and Group: Engineering Laboratory, Fire Research Division, Engineered Fire Safety Group

NIST Research Advisor: Amy Mensch

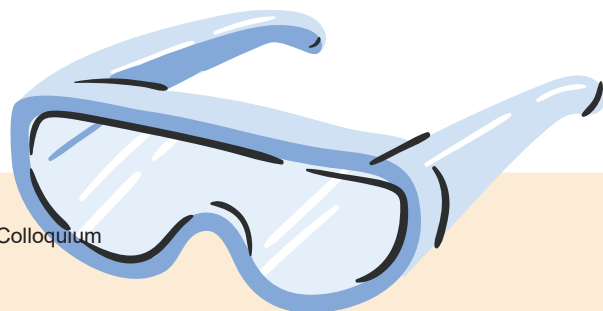
Title of Talk: Evaluating the Emissions of E-Scooter Fires

Abstract:

Over the past decade, the number of electric micromobility devices in American households has increased drastically. These devices pose a significant fire risk due to their use of Lithium-Ion batteries, which pose the inherent fire risk of catastrophic overheating known as thermal runaway. In addition to the thermal hazard, both thermal runaway and fire in lithium-ion batteries release toxic gases from the chemicals used in the battery's construction. In this work, the emissions of burning e-scooters are examined based on a series of previously conducted experimental measurements in NIST's National Fire Research Laboratory (NFRL). Experiments were performed: 1) in a 3.7 m x 3.7 m x 2.4 m room with one door-sized opening under a 10 MW fume hood and 2) in an open enclosure under a 500 kW fume hood. Both fume hoods were equipped with an oxygen consumption calorimetry system as well as FTIR for gas analysis. The room was instrumented with various heat flux, temperature, and gas analysis systems. The current analysis evaluates three different hazards: the incapacitation hazard in the room due to CO and HCN, the irritant gas buildup in the room that would hinder escape, and the buildup of explosive gas depending on the size of enclosure. Gas analysis of asphyxiating gases (carbon monoxide and hydrogen cyanide) was performed using the in-room FTIR measurements (taken around head height) and demonstrated that the risk of asphyxiation was very low. Gas analysis of irritant gases was performed using the same in-room FTIR measurements and demonstrated that irritant gases, particularly NO₂ and Formaldehyde, could easily build up to impairing levels, typically peaking before battery ignition and dispersing afterwards. Production of flammable gases, such as carbon monoxide and dimethyl chloride, was calculated using readings from the hood FTIR, and this analysis demonstrated that the total yield of flammable gases is low enough that an explosion could only occur if the e-scooter is stored in a small, sealed box. Overall, while the chemicals produced by e-scooter fires were typically not directly life-threatening, they commonly reached concentrations that would impair escape and make any fire afterwards more



Information Technology Laboratory 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Information Technology Laboratory (ITL) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Juliana Escuti (*plenary speaker*) - Continuous Validation of BF Specifications of Input/Output Check Related CWEs

Walter Roou - Lost in Terminology: How Everyday Americans Perceive Digital Identity Language

Isabella Tai - Investigating DevSecOps for IoT Device Development

Shaune Yeboah - Modernizing NIST Workforce Guidelines for an Evolving Digital Landscape

Mikias Kelela - Looking Through the Noise: Analysis of the Electromagnetic Side-Channel of AES Implementation

Brittney Meza - Streamlining Digital Identity: Practical Tools for Risk Management and Standards Tracking

Rajeev Raghuram - Using Secure Software Development Framework for AI Code Generation

Samuel Wang - Comprehensive Security Analysis and Development of a Testbed for the Openclaw Agentic AI System

Milo Reed - Formal BF Specifications of Injection Related CVEs

Qudus Bawa-Allah - Representation learning using Topological Data Analysis for Drug Discovery

Alex Srivastava - Deep Condition-Level Analysis of Automatic Speaker Recognition Systems for NIST SRE24

Anastasia Kutselik - Sandbox Data Generation for Forensic Deepfake Guideline

Kiran Manoj - Developing a Scoring Package and Baseline Detectors for Robustness Evaluation in Forensic Deepfake Detection

Vivek Vaidya - Developing Benchmark Datasets for Forensic Deepfake Detectors

Aaryav Walter - Real-time Voice Conversion for Critical Privacy Enhancement

Chloe Hall - Application of Object Detection Metrics for Assessing Multi-Finger Segmentation Algorithms

Ryan Kaplan - Developing an OpenFOAM-ParaView workflow for indoor airflow visualization in a Testing Facility

Alyse Graham-Martinez - Building a Tunable Optical Delay Line

Rebecca Gabrielsson - Exploratory Topological Data Analysis of PFAS Compounds

Henry Nonnemaker - Finite Difference Methods for Time-Dependent Modeling of an Optofluidic Flowmeter

Chris Jia - Active Stabilization of SiC Integrated Photonic Resonators for Robust Entangled Photon Generation

Arjun Parikh - Quantifying Uncertainty of Texture Directionality Prediction by Neural Networks

Vijay Jayasuriya - Quantification and Calibration of Uncertainty in ML-Classifiers Using Post-Hoc Methods

Alvin Guo - Using Machine Learning to Modify an Equation of State

Chelsea Zhang (CHIPS) - Evaluation of Image Scanning and Sampling Strategies for ML-based Dimensional Measurements of Integrated Circuits

Sophia Lin - Metrology for LLM-as-Judge Systems: Validating Grounding, Agreement, Robustness, and Integrity

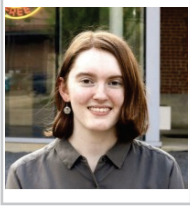
Nan Jiang - Benchmarking Instance Segmentation Models for Cross-Modality Automated Cell Segmentation

Ayush Talukder - Deep Computer Vision for Meniscus Artifact Removal from Medical Images

Ivy Guo - Training-free, Model-based Methods for Image Segmentation and Edge Detection

Akshay Karthik Manimaran (CHIPS) - Optimizing an Artistic Approach to Defect Detection in Advanced Semiconductor Packages

Ilana Johnson - Validating the Coefficient of Disagreement for Complex Biological Datasets



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Juliana Escuti

Academic Institution: Brown University

Major: Computer Science

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Grad School, PhD

**NIST Laboratory,
Division, and Group:** ITL, CSD, Software Security (773.03)

**NIST Research
Advisor:** Irena Bojanova

Title of Talk: Continuous Validation of BF Specifications of Input/Output Check Related CWEs

Abstract:

The cybersecurity landscape is evolving more rapidly than ever, as both humans and AI agents increasingly produce buggy code. A precise understanding of security bugs and their resulting errors is essential for experts and automated systems to analyze, reason about, and resolve/mitigate security vulnerabilities.

The Common Weakness Enumeration (CWE) is widely used but is susceptible to gaps, overlaps, and ambiguities. In contrast, the Bugs Framework (BF) provides a multidimensional representation of software bugs through strict taxonomies, formal models, and a formal language rather than being a one-dimensional repository. We validate BF against CWE to demonstrate that BF possesses the expressive power necessary to represent all known weaknesses and beyond.

This project continues the validation of the BF Input/Output Check (`_INP`) bug classes. The validation process involves analyzing the natural language descriptions and examples of relevant CWEs, manually identifying the BF bug, operation, and (final) error values, and comparing these results with previously developed BF specifications.

BF's orthogonal classification scheme enables the generation of hierarchical visualizations that highlight CWEs according to BF-based similarities, such as common operations, shared cause-operation relationships, and identical weakness triples. This work further extends existing CWE-to-BF visualizations by introducing force-directed graphs that support interactive node rearrangement and SVG export, enhancing understanding of CWE relationships and supporting future CWE analysis and BF refinement.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Walter Roou

Academic Institution: Christopher Newport University

Major: Information Science and Economics

Academic Standing (Sept. 2026): Graduate Student (M.S. in Data Science, University of Virginia)

Future Plans (School/Career): Master's Degree in Data Science

NIST Laboratory, Division, and Group: Information Technology Laboratory (ITL), TTED, Human-Centered Technologies Group

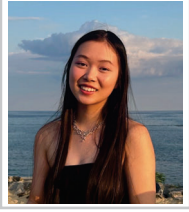
NIST Research Advisor: Yee-Yin Choong & Julie Haney

Title of Talk: Lost in Terminology: How Everyday Americans Perceive Digital Identity Language

Abstract:

Digital identity systems are often described by technical terminology that may be unfamiliar or confusing to the general public. Towards improving how digital identity terms are communicated, we surveyed 659 U.S. adults without specialized cybersecurity knowledge about six common digital identity terms: digital credential, digital identity, mobile driver's license, identity proofing, digital identity wallet and mobile wallet. We examined familiarity, understanding, and associated emotions across terms, age groups, and education levels. We also compared responses between two categories of digital identity terms: digital identity concepts (digital credential, digital identity, mobile driver's license, and identity proofing) and digital identity applications (digital identity wallet and mobile wallet). Ordinal logistic and linear regression analyses were performed in R, and descriptive statistics and data visualizations were created in Microsoft Excel.

We found that familiarity, understanding, and associated emotions differed significantly across digital identity terms. Level of understanding varied across terms, suggesting that some digital identity concepts are more understood by the public than others. Overall, participants who were more familiar with a term were more likely to associate it with positive emotions, while less familiar terms were more often associated with neutral or negative emotions. Age and education also influenced participants' results, but significant differences among terms remained after accounting for these demographic factors. These findings provide new insights into how the public interprets digital identity terminology and can help improve how digital identity terms are communicated.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Isabella Tai

Academic Institution: Johns Hopkins University

Major: Computer Science

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Graduate School

NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied Cybersecurity Division, Cybersecurity for IoT

NIST Research Advisor: Jeffrey Marron

Title of Talk: Investigating DevSecOps for IoT Device Development

Abstract:

The NCCoE Secure Software DevSecOps project is focused on developing an applied, risk-based approach for DevOps practices consistent with the Secure Software Development Framework (SSDF). The DevSecOps team developed a notional reference model for software development in order to demonstrate and document potential implementations of SSDF practices and tasks. They utilized this model in order to interpret the SSDF's recommended security practices in a practical software architecture development context. The DevSecOps project focuses solely on software development, but IoT devices face their own challenges when it comes to secure development.

As part of the Cybersecurity for IoT team, I investigated the development process of IoT devices with the intent to determine whether there was enough of a difference between IT and IoT development to warrant the creation of a DevSecOps project focusing on IoT development. Unlike in pure software development, IoT device developers must consider hardware and firmware requirements together. This means that IoT developers face hardware security challenges out of scope for the current software DevSecOps project when designing and producing products. These challenges include constraints on size and power consumption as well as scalability in quality control testing. In addition, established practices in software development such as agile development and regular software updates may not be possible when creating physical IoT devices, or may come with their own risks. The broad spectrum of devices that fall under the domain of IoT means that device capabilities can vary widely, and many IoT devices do not fit the model which the Software DevSecOps team is using. Along with the current IoT threat landscape, the difference in developmental processes facilitated by the presence of hardware and the risks and requirements thereof in IoT devices warrants further investigation through a full IoT DevSecOps project.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Shaune Yeboah

Academic Institution: University of Maryland

Major: Information Design

Academic Standing (Sept. 2026): Senior

Future Plans (School/Career): User Experience Research

NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied Cybersecurity Division, Cybersecurity and Privacy Applications Group, Privacy Engineering Program

NIST Research Advisor: Nakia Grayson

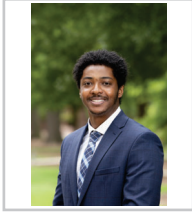
Title of Talk: Modernizing NIST Workforce Guidelines for an Evolving Digital Landscape

Abstract:

NIST plays a crucial role in developing several key workforce resources, including the National Initiative for Cybersecurity Education (NICE) Workforce Framework for Cybersecurity and the Privacy Workforce Taxonomy, to strengthen cybersecurity and privacy workforce development. Workforce development is important for both privacy and cybersecurity. Organizations need personnel with the knowledge, skills, and abilities to effectively protect and safeguard information, manage risks, and adhere to their legal and regulatory requirements.

My internship involved researching the role of the Privacy Compliance Officer in the NICE Framework, examining the knowledge, skills, and responsibilities required for the position both across industry and within the context of NIST's privacy initiatives. I analyzed existing Task, Knowledge, and Skill (TKS) statements to identify opportunities for improvement through updates, additions, and removals, ensuring they accurately reflect current privacy practices, emerging technologies, and evolving regulatory expectations. Based on this research, I developed recommendations to improve the accuracy, relevance, and completeness of the framework. My analyses contributed to broader efforts to modernize privacy within the NICE Framework and promote greater consistency across the Privacy Workforce Taxonomy.

Through this project, I gained practical experience in privacy governance, workforce framework development, standards analysis, technical research, and data organization while contributing to resources intended to support organizations in developing a skilled privacy and cybersecurity workforce and managing privacy and cyber risk more effectively.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Mikias Kelela

Academic Institution: University of Maryland College Park

Major: Computer Engineering

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Graduate School or Industry

**NIST Laboratory,
Division, and Group:** Information Technology Laboratory, Applied Cybersecurity, Cybersecurity and Privacy Applications.

**NIST Research
Advisor:** Dr. Nelson Hastings

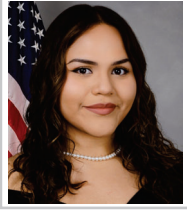
Title of Talk: Looking Through the Noise: Analysis of the Electromagnetic Side-Channel of AES Implementation.

Abstract:

Cryptographic algorithms, such as the Advanced Encryption Standard (AES) are mathematically secure, but their physical implementations on hardware can inadvertently leak sensitive information through power consumption and electromagnetic (EM) emissions. Side-channel analysis (SCA) exploits these physical leakages to extract secret cryptographic keys. Understanding these vulnerabilities across different hardware architectures is crucial for developing robust security countermeasures. This project explores the physical security of AES implementations by learning to capture and compare leakage characteristics across two distinct hardware platforms: a Spartan-7 FPGA on an Arty S7 board and an ARM Cortex-A7 microprocessor on a Raspberry Pi 2.

To facilitate this comparative study, we deploy AES-128 in ECB mode on both devices while employing specific strategies to isolate the cryptographic signals. On the FPGA, we implement a custom finite state machine to isolate the encryption process, while using physical blocks to constrain the AES logic into an isolated quadrant, maximizing localized EM emissions. Conversely, the Raspberry Pi implementation provides a software-centric perspective, allowing us to observe how an operating system and microprocessor architecture influence side-channel leakage.

Following the acquisition of EM traces from both the FPGA and the microprocessor, the ongoing phase of this project focuses on learning to process and analyze the data using the Inspector software to exploit the unprotected cryptographic design and recover the secret keys. We plan to conduct a Test Vector Leakage Assessment (TVLA) to statistically quantify the information leakage and evaluate the efficacy of our hardware isolation techniques. By evaluating the anticipated TVLA between the bare-metal FPGA and the microprocessor, we aim to build a foundational understanding of SCA and confirm whether our constraints successfully expose underlying cryptographic operations. This research ultimately serves as a hands-on learning platform to evaluate side-channel vulnerabilities across different architectures.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Brittney Meza

Academic Institution: University of North Georgia

Major: Computer Science

Academic Standing (Sept. 2026): Graduated with a Bachelor of Science in Computer Science (cum laude) in Spring 2026

Future Plans (School/Career): Work in computer security or computer forensics and then obtain a graduate degree in computer science.

NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied Cybersecurity Division, Cybersecurity and Privacy Applications Group

NIST Research Advisor: Ryan Galluzzo

Title of Talk: Streamlining Digital Identity: Practical Tools for Risk Management and Standards Tracking

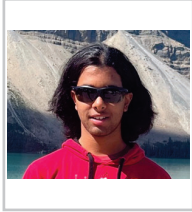
Abstract:

I supported two projects that contributed to NIST's Digital Identity Program by providing custom tools designed to assist the Program and other Federal Agencies in optimizing identity related tasks.

The first project centers on NIST Special Publication 800-63 Rev. 4 (Digital Identity Guidelines), which outlines a Digital Identity Risk Management (DIRM) process that private sector companies and government partners utilize to manage identity related risk. Feedback from stakeholders indicated that they desired tools to help implement the risk management process as defined in the guidelines. Thus, the DIRM Tool was developed. This web-based tool provides a step-by-step questionnaire that produces consistent risk reports that can more easily integrate with organizations' enterprise risk management processes. This task involved building upon the program's initial framework, developing new features, refining the tool, and contributing key design input.

The second project addresses a challenge specific the Digital Identity Program was facing. To do their jobs effectively, they must stay informed about identity standards and what Standards Development Organizations (SDOs) are creating. Because each SDO utilizes a different method of broadcasting updates and the abundant uptick of AI-related standards, keeping track of these changes manually was extremely time-consuming. The Identity Standards Status Tracker (ISST) web application provides an automated solution, pulling information from various sources and compiling it all into an easy-to-read user interface. This task encompassed research, design, development, and production of the application.

The presentation will provide an overview of the tools, the development process, a demo of the ISST web app, and lessons learned through both efforts.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Rajeev Raghuram

Academic Institution: University of California, Davis

Major: Data Science & Physics

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Pursue PhD in astrophysics, become professional astronomer

**NIST Laboratory,
Division, and Group:** Information Technology Laboratory (ITL), Computer Security Division, Security Engineering and Risk Management Group

**NIST Research
Advisor:** Mike Bartock

Title of Talk: Using Secure Software Development Framework for AI Code Generation

Abstract:

The Secure Software Development Framework (SSDF) sets important guidelines for developing code, including the use of a CI/CD pipeline (continuous integration, continuous deployment). When programming an application, it is important to follow SSDF guidelines in order to ensure that safe coding practices are followed to reduce the threat surface of code being produced.

The goal of my project is to build an application with a web frontend to scan any accessible code repository to find code vulnerabilities and their severities. It will use two different vulnerability scanning tools: Trivy to search for specific vulnerabilities based on their ID's (CVE or GHSA) and their corresponding CVSS severity scores, and Semgrep to search for specific lines of code that are vulnerable and how to fix them. It will then store the results of each scan in a MariaDB database, along with the repo name and URL, branch, commit ID and date/time, and any necessary authentication parameters (will be encrypted), and it will generate a downloadable Software Bill of Materials (SBOM). This will allow developers to identify and fix any security risks in their app prior to deployment.

We use a CI/CD pipeline to build the app in multiple stages, testing the functionality of each stage before adding enhancements, and pushing to our GitLab repository after each successful build stage. Since some of the code is AI generated, we have to continuously check to ensure that it follows the SSDF guidelines as we refine it and add more features, and create artifacts that map our coding practices to the SSDF.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Samuel Wang

Academic Institution: University of Massachusetts, Amherst

Major: Computer Science | Mathematics

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Pursue a career in Software Engineering

NIST Laboratory, Division, and Group: Information Technology Lab, Computer Security Division, Hardware Security Group, 773.02

NIST Research Advisor: Yang Guo

Title of Talk: Comprehensive Security Analysis and Development of a Testbed for the Openclaw Agentic AI System

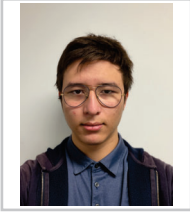
Abstract:

The recent emergence of Agentic AI Systems, such as Openclaw, allow Large Language Models (LLMs) to perform tasks such as writing and executing code or shell commands, responding to emails, or monitoring servers. This capability not only presents a remarkable opportunity to automate systems (including defensive systems), but also introduces a significant security risk, as these systems require elevated privileges on the user's computer, creating a critical attack surface.

In this project, we set up a testbed for the Openclaw Agentic AI system, the most prominent general-purpose agentic architecture. We provide an overview of Openclaw's architecture, and examine its vulnerabilities against OWASP Top 10 security risks for agentic applications. The attacks are repeated on our testbed. We show that while some attacks remain valid, others have been mitigated by recent updates to Openclaw.

We further develop a preliminary pipeline for an agentic AI system using distributed agents and tools. This pipeline is easily scalable, showcasing the potential of agentic AI for distributed security monitoring, logging, and threat detection.

Our work shows both the potential applications and the security risks of agentic AI systems, raising security awareness while exploring their tremendous potential.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Milo Reed

Academic Institution: Purdue University

Major: Computer Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Grad School

NIST Laboratory, Division, and Group: ITL, CSD, Software Security (773.03)

NIST Research Advisor: Irena Bojanova

Title of Talk: Formal BF Specifications of Injection Related CVEs

Abstract:

Injection-related vulnerabilities are among the most dangerous and frequently occurring software vulnerabilities. Their descriptions in the Common Vulnerabilities and Exposures (CVE) repository are written in natural language, which often introduces ambiguity, emphasizes the final error rather than the root cause, and provides limited insight into the underlying weaknesses. As a result, both security experts and automated systems lack a precise and consistent representation of injection vulnerabilities and their real-world manifestations.

The Bugs Framework (BF) addresses this limitation by representing vulnerabilities as formal causal chains of weaknesses that adhere to strict syntax, semantics, and definitions. This representation ensures an unambiguous and comprehensive description of vulnerabilities, while capturing both their high-level structural anatomy and their specific codebase implementation details in a precise, succinct format.

This work focuses on the BF Data Validation (DVL) Bugs Class, which models the operations, causes, and consequences associated with processing input and output data. In particular, we investigate vulnerabilities that arise from missing or incorrect Validate or Sanitize operations and ultimately result in injection errors. Using previously extracted vulnerable and patched GitHub code associated with injection-related CVEs, we perform deep code analysis to identify the unique (bug, operation, final error) triple corresponding to each one-weakness Injection vulnerability instance.

The resulting new BF injection vulnerabilities dataset is intended to support automated validation, provide reinforced learning examples for the automated generation of BF specifications by AI systems, document edge cases, and establish decision rules for complex and nuanced scenarios.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Qudus Bawa-Allah		
Academic Institution: Rochester Institute of Technology		Major: M.S. Applied and Computational Math
Academic Standing (Sept. 2026): Graduate Student		
Future Plans (School/Career): PhD in Math Modeling		
NIST Laboratory, Division, and Group: ITL		
NIST Research Advisor: Dr. Chandramouli Ramaswamy & Dr. Sarala Padi		
Title of Talk: Representation learning using Topological Data Analysis for Drug Discovery		
Abstract: The rise of antimicrobial resistance (AMR) poses a significant threat, potentially returning clinical medicine to pre-antibiotic mortality rates. This makes antimicrobial peptides (AMPs) a promising therapeutic alternative due to their distinct mechanisms of action. However, the discovery of AMPs is increasingly reliant on computational screening techniques. Current sequence-based predictors demonstrate strong performance in classifying generated AMPs as active or inactive but accurately identifying and rejecting non-AMPs (inactive candidates) remains a critical challenge in high-throughput screening. In this study, we explore whether topological data analysis (TDA), which extracts physically interpretable and isometry-invariant descriptors of molecular structure from ESMFold-predicted protein models, can serve as a complementary approach to modern protein language model embeddings. We utilized the AMPDiscover benchmark dataset for our experimental evaluations. First, we extracted ESM2 embeddings alongside persistent homology (PH), element-specific persistent homology (ESPH), and an electrostatic persistent Laplacian (PL), which was derived from AMBER ff14SB partial charges for the sequences. Then, we employed these features for a binary classification task (AMP vs. non-AMP) by developing models using random forests, XGBoost, and multilayer perceptron with early fusion techniques. We assessed performance using accuracy, and true negatives (TN) as primary metrics, as minimizing false positives during candidate screening is crucial. Our results demonstrate that TDA-derived features capture an important portion of the predictive signal identified by ESM-2 embeddings, while also providing a level of interpretability that dense learned embeddings lack. By combining structural descriptors with sequence representations from ESM-2 embeddings, this approach creates a more transparent framework for AMP prediction and insights into antimicrobial activity.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Alex Srivastava

Academic Institution: University of Maryland, College Park

Major: Electrical Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Graduate school in quantum science and engineering

NIST Laboratory, Division, and Group: Information Technology Lab, Technology Testing and Evaluation Division, Biometrics Technologies Group

NIST Research Advisor: Dr. Craig Greenberg

Title of Talk: Deep Condition-Level Analysis of Automatic Speaker Recognition Systems for NIST SRE24

Abstract:

Automatic speaker recognition systems are used in a variety of forensic and security tasks that require careful measurements of their performance. In order to provide such a measurements, in 2024 NIST held the latest in an ongoing series of Speaker Recognition Evaluations, SRE24. Academic and industry research groups from all around the world sent automatic speaker recognition system outputs to NIST for SRE24, where each system output consisted of log-likelihood ratio scores for millions of speaker verification trials conducted in multiple languages and speaking and recording conditions. This work is focused on creating a comprehensive analysis of SRE24 results and makes use of an analysis pipeline, named "Juicer", which is capable of analyzing those system submissions at both an aggregated level as well as by taking into account the fine-grained experimental conditions present in SRE24, such as speaker gender, audio source type (either telephone or audio from video), language match between enrollment and test segments, enrollment and test segment duration, and number of audible speakers. The pipeline processes a large set of trials, along with 35 submitted system outputs, filtering them by each analysis condition, , and calculates commonly used performance metrics like min DCF and EER on the resulting subsets, yielding 1,645 condition-level performance scores. Accomplishing this analysis involved the design, implementation, testing and debugging of the whole pipeline, ensuring reproducibility of its results, and producing the comprehensive analysis scores and graphs and preparing them for journal publication.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Anastasia Kutselik

Academic Institution: University of Maryland, College Park

Major: Information Science

Academic Standing

(Sept. 2026): Junior

Future Plans

(School/Career): Bachelors in Information Science and work in the field of AI

NIST Laboratory,

Division, and Group: ITL/TTED/MLT

NIST Research

Advisor: Dr.Haiying Guan

Title of Talk: Sandbox Data Generation for Forensic Deepfake Guideline

Abstract:

The Sandbox dataset is part of the Guardians of Forensic Evidence(GoFE) project addressing a critical need by equipping the judiciary, law enforcement, and forensic communities with the tools and methodologies required to independently verify, validate, and evaluate automated deepfake detection software.

With the rise of AI and the complexity of its abilities many are using it to their advantage in insurance fraud and to submit as evidence for court. Falsified evidence has become a growing issue to which a solution must be found. Sandbox dataset focuses on how realistic and undetectable AI images can be in the form of fully synthetic or local deepfaked images. Generated images were tested against various detectors to show how better advancement is needed for detection. The naked eye is no longer enough to detect falsified images, so further tools are needed that can detect usage of AI.

We used the newest AI tools to generate falsified images in different topics of forensics to stimulate images that people may submit as false evidence. These images were then tested against newest commercial detectors that are available to the public to see how well or poorly they perform. These same images went through post-processing(resize, gaussian blur,etc) and tested against the same detectors to see what factors play into the performance of newest commercial detectors.

Sandbox Dataset highlights how realistic AI images can be and how easy it is to manipulate an image without being an expert or paying for special programs. Sandbox dataset goes to show how newest commercial detectors are not 100% accurate, allowing for some falsified images to slip past detection. Hence we need better systems to filter out AI manipulated images in the forensic domain to improve integrity of evidence submitted.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Kiran Manoj

Academic Institution: University of Maryland College Park

Major: Computer Science

Academic Standing Senior
(Sept. 2026):

Future Plans Pursue Combined BS/MS in Computer Science, then a career in Data Science/ML
(School/Career):

NIST Laboratory, Division, and Group: Information Technology Lab, Multimedia Language Technologies Group (MLT), Technology Test and Evaluation Division (TTED)

NIST Research Advisor: Haiying Guan

Title of Talk: Developing a Scoring Package and Baseline Detectors for Robustness Evaluation in Forensic Deepfake Detection

Abstract:

Generative AI has made it possible to create images and videos that are difficult to distinguish from reality, and this has serious consequences for forensic and legal investigations. Digital evidence can no longer be assumed authentic, yet forensic examiners currently have no standardized way to know whether an automated deepfake detector will actually perform reliably outside a controlled research setting. Many detectors report strong accuracy on academic benchmarks, but that performance can drop sharply when the same tool is applied to real forensic conditions such as compressed video, low-quality surveillance footage, or images altered to evade detection. Closing this gap between lab performance and forensic reliability is central to our work on NIST's Guardians of Forensic Evidence (GoFE) project.

My contribution focuses on building the evaluation infrastructure that makes this kind of testing possible. I developed a Python-based scoring package that computes standardized performance metrics, including ROC curves, Area Under the Curve (AUC), and Correct Detection Rate at a fixed False Alarm Rate, so that different detectors can be compared consistently regardless of how they were designed. Alongside this, I am testing multiple deepfake detectors and surveying current state-of-the-art detection algorithms to establish a reference point for the field. Using this infrastructure, I assessed how detector performance changes under forensic-realistic degradation, identifying where and why reliability breaks down.

This work is intended to serve as shared measurement infrastructure for the broader GoFE evaluation framework, giving researchers and forensic practitioners a consistent, transparent way to assess detector performance rather than relying on self-reported benchmarks. As synthetic media becomes harder to identify through visual inspection alone, forensic examiners will increasingly depend on tools like these to support authentication decisions in real investigations. Establishing rigorous, standardized evaluation now is a necessary step toward making that dependence a trustworthy one.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Vivek Vaidya

Academic Institution: Rutgers University

Major: Computer Science and Statistics

Academic Standing Junior
(Sept. 2026):

Future Plans MS or Industry
(School/Career):

NIST Laboratory, Division, and Group: Information Technology Lab, Technology Test and Evaluation Division, Multimedia Language Technologies Group

NIST Research Advisor: Haiying Guan

Title of Talk: Developing Benchmark Datasets for Forensic Deepfake Detectors

Abstract:

As synthetic image generation tools become increasingly realistic, forensic examiners must rely more heavily on automated detection tools. While substantial research has been dedicated to developing synthetic image detectors, a persistent challenge is that most of these models suffer a severe drop in accuracy when deployed in real-world scenarios. The root cause of this trend is a fundamental gap between the controlled datasets used to train and test these models, and the diverse synthetic images encountered "in the wild." Consequently, forensic examiners need to understand exactly where these detectors fail and how to properly vet them before relying on their outputs in legal or court settings.

To expose this gap and quantify detector degradation, this work implements a deepfake evaluation dataset generation infrastructure to generate the GoFE Deepfake Challenge Dataset. Our pipeline draws deepfake images from a diverse range of generators and applies a series of post-processing and social media "image laundering" steps to both real and deepfake images, effectively simulating the real-world transformations an image undergoes when shared online.

Using this pipeline, we generated two Challenge Datasets (incorporating a set of generators and up to 90,000 images). Each offers a "Lite" package of final-stage images and a "Full" package of all intermediate stages to track performance drops during degradation. We are now expanding this infrastructure into the GoFE Deepfake Benchmark Dataset, featuring more generators categorized into five forensic domains to pinpoint specific detector blind spots. Ultimately, our deepfake datasets will help the forensic community better understand evaluation infrastructures, standardize the vetting process for detectors, and move the field closer to reliable deepfake media authentication.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Aaryav Walter

Academic Institution: University of Virginia

Major: Computer Science

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Enter Software and AI Industry, Attend Graduate School

NIST Laboratory, Division, and Group: ITL, Technology Test and Evaluation Division, Multimedia Language Technologies Group

NIST Research Advisor: Kevin Mangold

Title of Talk: Real-time Voice Conversion for Critical Privacy Enhancement

Abstract:

Voice Conversion (VC) models have spanned traditional signal processing, statistical methods, hybrid AI models, before adopting end-to-end deep learning pipelines that scale in speed and accuracy. Popular VC model architectures include neural codec language, zero shot voice cloning, and diffusion and flow-matching models. VC pipelines traverse audio data through a series of intelligent models that each complete specific tasks such as audio data preprocessing, speaker audio encoding, target voice encoding, voice transformation, and voice refinement.

In this project, we propose a reduced latency VC system suitable for real world applications including privacy protection, translation, and streaming. The pipeline leverages a latency efficient architecture to perform tasks such as audio automatic speech recognition and text to speech to effectively convert a speaker's voice into a target voice. End users can choose a pre-configured target persona within the pipeline's audio database or add an external speech audio file to the database to create a new persona.

We propose application enhancements for future development including a real-time sustainable generative adversarial network to deepen target voice clarity, investigate further latency reduction methods, and support foreign languages for voice conversion.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Chloe Hall

Academic Institution: University of Maryland, College Park

Major: Info. Svstems + Cell Bio. & Genetics

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Graduate School

NIST Laboratory, Division, and Group: Information Technology Laboratory, Technology Test and Evaluation Division, Biometric Technologies Group

NIST Research Advisor: Gregory Fiumara

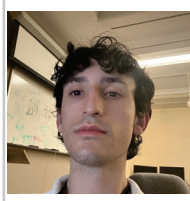
Title of Talk: Application of Object Detection Metrics for Assessing Multi-Finger Segmentation Algorithms

Abstract:

Fingerprint segmentation is an important computer vision task in current fingerprint recognition systems. Effective segmentation algorithms must accurately localize the distal phalanx region of each finger by producing a tightly fitting, correctly oriented bounding box that closely matches a human-drawn bounding box, while also handling cases involving missing or amputated fingers. Fully automated fingerprint identification systems are sensitive to even small pixel-level or rotational errors, so precise localization is critical. Oversized boxes may introduce noise by including adjacent fingers, while undersized boxes may hinder successful recognition by excluding ridge data.

Object detection metrics quantify how closely an algorithm-generated bounding box aligns with a human-drawn bounding box. NIST assesses slap segmentation algorithms in its SlapSeg evaluation program. The scoring method used in the evaluation determines correctness by checking whether the corners of the algorithm-generated box fall within a fixed pixel tolerance of the corresponding ground truth corners, with a small rotational allowance. Although seemingly straightforward, this method requires comparing multiple values and may not fully capture bounding box accuracy, especially when errors involve more nuanced differences in overlap and rotation.

With the growth of computer vision object detection domains (e.g., autonomous driving, scene text recognition, and satellite imagery), there are new methods of assessing accuracy. This project investigates if these alternative object detection metrics are suitable for evaluating fingerprint segmentation algorithms. The goal was to compare different metrics and recommend a more robust metric or combination of metrics that more accurately measures bounding box accuracy. An extensive literature review was conducted to identify relevant metrics and assess their usefulness to fingerprint segmentation. The metrics were then implemented in Python and applied to real data from NIST's segmentation algorithm evaluation to observe fitness for purpose.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ryan Kaplan

Academic Institution: University of Maryland, College Park

Major: Applied Mathematics

Academic Standing (Sept. 2026): Rising Senior

Future Plans (School/Career): Graduate School

NIST Laboratory, Division, and Group: ITL

NIST Research Advisor: Simon Su

Title of Talk: Developing an OpenFOAM-ParaView workflow for indoor airflow visualization in a Testing Facility

Abstract:

Our project is aiming to develop a computational workflow for visualizing indoor airflow in the NIST Net-Zero Energy Residential Testing Facility using OpenFOAM and ParaView. Architectural floor plans and HVAC drawings are being used to construct a simplified first-floor air volume geometry and identify supply, return, and exhaust locations. These building and mechanical drawing measurements are converted into an OpenFOAM mesh with boundary patches representing HVAC devices, allowing airflow simulations to be solved and visualized using velocity magnitudes and streamlines in ParaView. The current stage of the project has produced a working prototype that includes a measured first-floor polygon, multiple supply vents, return vents, and an exhaust vent. The prototype demonstrates the full pipeline from building documentation to CFD mesh generation, boundary-condition assignment, solver execution, and visualization. Over the remainder of the project, the model will be refined by improving the geometry, checking vent placement and sizing, incorporating additional HVAC features such as transfer grilles, and incorporating a full-scale model of every object in the first-floor of the testing facility. The final goal will be to create a more accurate and reusable workflow for connecting building geometry, HVAC information, and airflow visualization in a residential testing environment.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Alyse Graham-Martinez

Academic Institution: Yale University

Major: Physics and Philosophy

Academic Standing Junior
(Sept. 2026):

Future Plans PhD in Applied Physics
(School/Career):

NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied and Computational Mathematics Division, Quantum Information Group

NIST Research Advisor: Yicheng Shi and Ollie Slattery

Title of Talk: Building a tunnable optical delay line

Abstract:

Among quantum networking protocols, entanglement swapping is particularly demanding: it relies on interfering photons that originate at separate, distant nodes. The photons must share polarization, central wavelength, and bandwidth, and – critically – must converge on the interference point within a few picoseconds of each other after transiting long fiber links. However, fiber propagation delay is not static. Environmental variables – most notably temperature – can lengthen the effective time-of-flight by tens of nanoseconds, corresponding to a path-length change of several meters, so the mismatch between two links must be corrected on an ongoing basis. To remedy this, one can add a tunable delay to the shorter link until the two paths match, requiring a line spanning tens of nanoseconds while still resolving steps on the order of 0.01 ps.

We propose building such a delay line using an optical-switch architecture. Two fiber switches route light through a selectable bank of fiber segments whose lengths differ incrementally (0.5 m, 0.6 m, 0.7 m, etc), yielding coarse steps of a few hundred picoseconds over a wide span. A protocol was developed to manually manufacture fiber patch cords for custom length segments. Cascading this stage with a commercial fine-delay unit (0–500 ps, 0.01 ps resolution) supplies the remaining resolution, so the combined system delivers broad range and ultrafine control together. Once assembled with an optical switch module, the device was programmed to perform custom path selection to suit the environmental conditions.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Rebecca Gabrielsson

Academic Institution: Coe College

Major: Mathematics and Physics

Academic Standing Senior
(Sept. 2026):

Future Plans Graduate School in Applied Mathematics or Mathematical Physics
(School/Career):

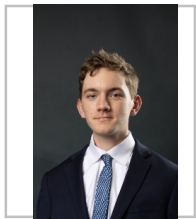
NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied and Computational Mathematics Division, Mathematical Analysis and Modeling Group

NIST Research Advisor: Anthony J. Kearsley

Title of Talk: Exploratory Topological Data Analysis of PFAS Compounds

Abstract:

Perfluoroalkyl and polyfluoroalkyl substances (PFAS) form a group of synthetic chemical compounds used in areas such as semiconductor manufacturing, biotechnology, and fire suppression. These compounds resist degradation, and there are concerns that PFAS exposure leads to negative impacts on people and the environment. This imposes substantial costs on businesses and the government. To understand and reduce reliance on PFAS, metrological techniques such as infrared spectroscopy and mass spectrometry are used to measure their properties. Comparing PFAS compounds is of particular interest. Traditional methods such as principal component analysis and multidimensional scaling accomplish this by projecting high-dimensional data to low-dimensional spaces. This enables more tractable visualization and analysis. In contrast, topological data analysis (TDA) determines how data points are related while retaining their full dimensionality. Molecular geometry data was acquired for a large database of PFAS molecules. Many-body tensor representations were used to encode the atoms, bonds, and bond angles present in each molecule. An exploratory TDA technique called the Mapper algorithm was applied, which uses topological coverings and clustering algorithms to generate graphs representing the fundamental structure of the dataset. Results of our analysis will be presented.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Henry Nonnemaker

Academic Institution: Case Western Reserve University

Major: Applied Math, English (secondary)

Academic Standing Junior

(Sept. 2026):

Future Plans Graduate school in applied math

(School/Career):

NIST Laboratory, Division, and Group: Information Technology Laboratory, Applied and Computational Mathematics Division, Math Modeling Group

NIST Research Advisor: Dr. Allison Carson

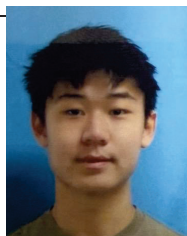
Title of Talk: Finite Difference Methods for Time-Dependent Modeling of an Optofluidic Flowmeter

Abstract:

Accurately measuring micro and nanoscale flow speeds is a critical practical challenge in a variety of fields. In medicine, for instance, drug dosage is determined by flow rate measurements when using IV infusion therapies. Current commercial flowmeters, such as those employing gravimetric methods or micro-particle imaging velocimetry, struggle to measure these slow flow rates responsively and dynamically. Researchers at NIST have patented the optofluidic flowmeter, which measures the amount of light emitted from fluorescent dye particles traveling through a microchannel when they are exposed to a laser. This technology has been shown to overcome this critical measurement shortfall.

Mathematical modeling of the optofluidic flowmeter provides further insight into the instrument's dynamics. I develop a time-dependent simulation of the flowmeter, which will enable the investigation of time-dependent perturbations in flow speed and their impact on flow rate measurements. I use a finite difference method to numerically approximate the solution to an advection-diffusion-reaction equation that models the concentration of unbleached particles in the microchannel. I consider the issue of treating the reaction term implicitly or explicitly, and analyze the resulting impact on the numerical error and time step restriction.

This work facilitates the eventual transfer of the optofluidic flowmeter to commercial applications and aids in instrument design research. Moreover, developing this simulation enables future uncertainty quantification investigations, which would be unattainable with commercial software packages as their closed-source nature makes such pursuits impossible.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Chris Jia

Academic Institution: Cornell University

Major: Information Science

**Academic Standing
(Sept. 2026):** Good Standing

**Future Plans
(School/Career):** PHD / Research

**NIST Laboratory,
Division, and Group:** Quantum Information Group, Information Technology Laboratory

**NIST Research
Advisor:** Lijun Ma, Anouar Rahmouni

Title of Talk: Active Stabilization of SiC Integrated Photonic Resonators for Robust Entangled Photon Generation

Abstract:

Silicon carbide (SiC) is an emerging platform for quantum information processing and integrated photonics due to its broad optical transparency window, strong optical nonlinearities, and compatibility with scalable device integration. Its high thermal conductivity and exceptional mechanical robustness further enable reliable operation in harsh environments and support applications in sustainable technologies. Recently, the NIST quantum information group demonstrated an entangled photon source based on a silicon-carbide-on-insulator (SiCOI) micro-ring resonator.

However, maintaining stable resonant operation remains a major challenge. When the pump laser is tuned to the micro-ring cavity resonance, optical absorption generates local heating, which shifts the resonance wavelength away from the fixed pump wavelength. As the resonance dip drifts away from the laser frequency, the coupling efficiency rapidly degrades, ultimately suppressing nonlinear optical processes and photon-pair generation.

This project develops an active software-based feedback system to track the resonator transmission dip in real time and dynamically adjust the pump laser wavelength to maintain resonance. Two locking strategies are implemented and compared: (1) a side-of-fringe locking method, which stabilizes the laser at a predefined operating point on the resonance slope, and (2) a dither locking method, which periodically modulates the laser across the resonance minimum and uses the extracted error signal to lock directly to the resonance center. Both approaches are evaluated using low-Q and high-Q SiCOI micro-ring devices to quantify their stability and robustness against thermal drift. Active resonance stabilization enables sustained operation of high-Q SiC photonic devices, where thermal effects are most pronounced, providing a critical capability for practical integrated quantum photonic systems.





SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Arjun Parikh

Academic Institution: Cornell University

Major: Biological Engineering

Academic Standing (Sept. 2026): Masters in Engineering

Future Plans (School/Career): PhD in Biomedical Engineering

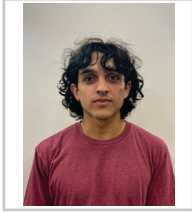
NIST Laboratory, Division, and Group: ITL, AI Research, Measurement, and Standards Division

NIST Research Advisor: Derek Juba

Title of Talk: Quantifying Uncertainty of Texture Directionality Prediction By Neural Networks

Abstract:

Texture directionality is vital for many different applications such as biomedical imaging, material science, environmental science, and so much more. Building on my work from last summer, the project I will present focuses on using neural networks to classify directional patterns in image data and then measuring how reliable the model's confidence scores are. A major part of the work is building calibration curves, which compare the model's predicted confidence to how often it is actually correct, so we can tell whether the model is overconfident, underconfident, or well calibrated. The overall goal is to make the model's predictions more interpretable and trustworthy by connecting classification accuracy, uncertainty, and confidence visualization.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Vijay Jayasuriya

Academic Institution: University of Maryland, College Park

Major: Computer Science, Math

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Software Engineering

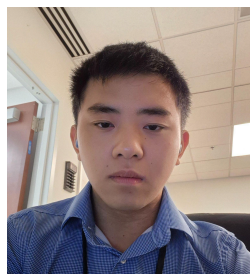
**NIST Laboratory,
Division, and Group:** Information Technology Laboratory, AI group

**NIST Research
Advisor:** Dr. Derek Juba

Title of Talk: Quantification and Calibration of Uncertainty in ML-Classifiers using Post-Hoc Methods

Abstract:

Reliable probabilistic outputs are essential for machine learning (ML) based decision support, particularly in biomedical imaging where uncertainty directly impacts diagnostic confidence. This project investigates uncertainty quantification and calibration strategies, specifically confidence calibration using histogram binning and multi-class calibration using class-wise binning and temperature scaling, to transform the raw scores of arbitrary pretrained classifiers into well-calibrated probability estimates. The methods are evaluated on a four-dimensional (channel x depth x height x width) mouse tongue imagery dataset, where each voxel represents a rich measurement of tissue microstructure. Pretrained convolutional neural network classifiers are fine-tuned or used as feature extractors predicting tissue type, and their logits are subsequently calibrated using the post-hoc techniques on a hold-out validation set. Calibration is assessed with standard metrics (expected calibration error, Brier score, and negative log-likelihood) and visualized via reliability diagrams and confidence heatmaps. Results demonstrate that pre-existing calibration techniques greatly improved estimated calibration error within novel data structures. Binning methods, though computationally inexpensive and reliable over large datasets, show especially high refinement loss in less frequently occurring classes. Overall, calibrated probabilities exhibit improved alignment between predicted confidence and empirical accuracy, enabling more trustworthy risk-aware decisions in downstream applications such as lesion detection and tissue segmentation. This work underscores the necessity of post-hoc calibration even for sophisticated, pretrained models when deployed in diagnostic biomedical imaging tasks.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Alvin Guo

Academic Institution: University of Chicago

Major: Math & Physics

Academic Standing

(Sept. 2026): 3.62 Cumulative GPA

Future Plans

(School/Career): Graduate School

NIST Laboratory,

Division, and Group: ITL

NIST Research

Advisor: Alexandros Chremos

Title of Talk: Using Machine Learning to Modify an Equation of State

Abstract: Statistical Associating Fluid Theory (SAFT) is a versatile equation of state (EoS) widely utilized in the pharmaceutical and petrochemical industries to model liquid-vapor equilibria across diverse temperature and pressure ranges. While SAFT derives thermodynamic properties from a closed-form Helmholtz free energy expression based on the Mie interaction potential, it deviates from molecular simulation results based on the same models, particularly for systems with molecular parameters that correspond to a softer interaction potential. This study proposes a correction term for the monomer contribution to the SAFT EoS to bridge the gap between theoretical predictions and simulation data. Utilizing DESPASITO—an open-source Python library for SAFT calculations—integrated with machine learning and symbolic regression methods, we identified the optimal functional form for this correction. The resulting modified EoS demonstrates significant improvement in predictive capability compared to the standard version of SAFT.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Chelsea Zhang

Academic Institution: Cornell University

Major: Electrical and Computer Engineering

**Academic Standing
(Sept. 2026):** Sophomore

**Future Plans
(School/Career):** Pursue a career in tech or hardware/chip industry; Master's in Electrical and Computer Engineering

**NIST Laboratory,
Division, and Group:** ITL, AI Research, Measurements, and Standards, 775.02

**NIST Research
Advisor:** Peter Bajcsy and Pushkar Sathe

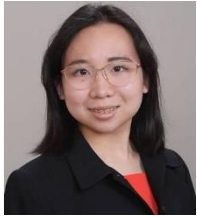
Title of Talk: Evaluation of Image Scanning and Sampling Strategies for ML-based Dimensional Measurements of Integrated Circuits

Abstract:

Dimensional measurements of integrated circuits (ICs) at the atomic scale are crucial for ensuring IC performance, reliability, and fabrication yield. Traditional measurement techniques are now limited by spatial resolution, sensitivity, noise, and speed. To meet the demands, artificial intelligence (AI) and machine learning (ML) must be integrated into semiconductor metrology, facilitating precise, fast, real-time measurements at atomic or near-atomic scales. NIST is interested in improving scanning electron microscope (SEM) dimensional measurements using AI and ML.

This project investigates various IC scanning strategies and sparse image sampling strategies, which are part of compressed sensing and used in scanning electron microscopy (SEM). A set of measured SEM images are sampled at varying degrees, inpainted (interpolated) using multiple AI inpainting models, and evaluated at a priori known line edge locations for their PSNR and SSIM as a function of the SEM image quality, measurement sparsity degree, and the methods used for scanning, sampling, and inpainting.

We evaluate scanning and sampling methods that are agnostic to the image content. Specifically, we compare reconstructed SEM images from Gilbert curve based scanning (a generalized, space-filling variant of the Hilbert curve) against Latin Hypercube (equal probability interval-based sampling) and Monte Carlo sampling. These scanning and sampling strategies have implications for the spatially distributed uncertainty of the inpainted SEM images when AI-based models are used to reconstruct the original image content from those sampled sets. We report such comparisons by focusing on PSNR and SSIM measurements, a common metric used by the semiconductor industry to assess image quality in the chip fabrication processes.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Sophia Lin

Academic Institution: Harvard University

Major: Computer Science

Academic Standing (Sept. 2026): Second-Year College Student

Future Plans (School/Career): Complete an A.B./S.M. in Computer Science at Harvard and pursue a graduate degree

NIST Laboratory, Division, and Group: ITL; AI Research, Measurement, and Standards Division; Group 775

NIST Research Advisor: Michael Majurski

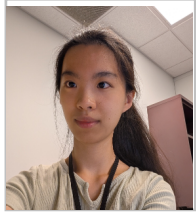
Title of Talk: Metrology for LLM-as-Judge Systems: Validating Grounding, Agreement, Robustness, and Integrity

Abstract:

Large language models (LLMs) are increasingly used as judges to evaluate, classify, and summarize large text corpora in workflows requiring reproducible, auditable, evidence-grounded judgments comparable to human judgment. Clean-label agreement is insufficient: judges may fail under formatting changes, rely on memorized rather than supplied evidence, follow incorrect references, or reach correct verdicts for flawed reasons. I developed a validation and calibration framework for open-weight LLM judges across a progression of increasingly demanding research questions. I begin by testing whether a judge can verify a pre-specified claim against explicit source text, identify the supporting evidence span, and abstain when the source does not contain an answer. I then test whether it can decompose a natural-language sentence into atomic claims, verify each claim against the source, and weight major versus minor unsupported details in a way that matches human annotators. Next, I use counterfactual source documents to determine whether verdicts are causally driven by the provided evidence rather than by the model's parametric memory. I subsequently measure whether those verdicts remain stable under irrelevant changes in formatting, ordering, verbosity, and evidence placement. From there, I test whether the judge can detect information that the source does not say, including both contradictions and unsupported additions in generated summaries. I also evaluate whether it preserves independent judgment when presented with an authoritative-seeming but incorrect reference answer. After establishing these capabilities, I calibrate its subjective summary judgments against expert human ratings of coherence, consistency, fluency, and relevance. Finally, I apply the validated quality judge to newly generated summaries and use the validated claim-decomposition and source-verification probes to measure their factual faithfulness, creating a generator-judge cascade whose downstream conclusions inherit their credibility from independently validated evaluation procedures. I compare the calibrated open-weight model with lower- and higher-capacity models to determine what reliability is gained or lost as model capacity changes.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Nan Jiang		
Academic Institution: University of Maryland-College Park		Major: Computer Science
Academic Standing (Sept. 2026): May 2028		
Future Plans (School/Career):		Undecided
NIST Laboratory, Division, and Group:		Information Technology Lab AI Research, Measurement, and Standard's Division, Applied AI Research Group
NIST Research Advisor:		Joe Chalfoun
Title of Talk:		Benchmarking Instance Segmentation Models for Cross-Modality Automated Cell Segmentation
Abstract: The 'Reproducibility Crisis' in preclinical research represents a multi-billion dollar challenge. Inherent biological variability often leads to inconsistent results between facilities, characterized by up to 200-fold variation in drug responses despite the use of standardized protocols. This inconsistency results in an estimated annual loss of \$28.2 billion in the US, with biological materials and reagents contributing to over 36% of this irreproducibility. Consequently, the current model of shipping live cells is no longer sufficient. NIST envisions replacing physical shipments with 'Digital Twins'—standardized digital reference states that can be generated locally. However, the realization of this vision depends on developing models that remain robust across different imaging modalities. Currently, models developed on specific devices often fail when deployed across laboratories utilizing different hardware. As part of the Digital Twin project, we have developed a robust data engineering pipeline that automatically generates ground-truth masks using Cellpose for instance segmentation. To ensure that differing hardware does not yield divergent results, we are independently auditing the generated datasets and benchmarking alternative instance segmentation architectures against our Cellpose baseline to determine the optimal model for production deployment.		

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Ayush Talukder		
Academic Institution: Purdue University		Major: Computer Engineering
Academic Standing (Sept. 2026):		Sophomore
Future Plans (School/Career):		Job
NIST Laboratory, Division, and Group:		NIST Information & Technology Laboratory, Applied AI Research Group
NIST Research Advisor:		Dr. Joe Chalfoun
Title of Talk:		Deep computer vision for meniscus artifact removal from medical images
Abstract: Phase Contrast Microscopy (PCM) is a powerful non-invasive imaging technique used to capture translucent cells by mapping light's phase changes. However, the utility of PCM is often hindered by the "meniscus effect," where liquid curves around the edge of the dish, refracting light and lowering contrast to the point that the image edges become unusable. In this project, we address this challenge by treating the correction of the meniscus effect as an image-to-image regression task using artificial intelligence to manually increase image contrast in affected regions. We evaluated a diverse range of model architectures, including standard convolutional networks such as U-Net and FCDenseNet, as well as hybrid transformer-based models like Uformer and SwinUNETR. Our results indicate that U-net architectures without transformer mechanisms performed the best on this task. Specifically, FCDenseNet achieved the highest validation SSIM, while U-Net demonstrated the fastest training time while maintaining similarly high structural similarity (SSIM). While transformer mechanisms such as those in Uformer showed promise in accuracy, they required significantly longer execution times without providing a proportional increase in performance. This research highlights the effectiveness of U-Net based architectures in mitigating the meniscus effect in PCM, providing a scalable solution for improving the usable area of cellular imaging.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ivy Guo

Academic Institution: Massachusetts Institute of Technology

Major: Computer Science and Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): software engineering or master's in machine learning

NIST Laboratory, Division, and Group: ITL Statistical Engineering Division

NIST Research Advisor: John Lu

Title of Talk: Training-free, model-based methods for image segmentation and edge detection

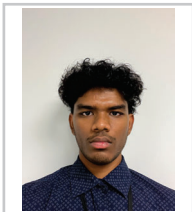
Abstract:

Image segmentation is the process of partitioning an image into multiple regions of shared characteristics, for example distinguishing between a foreground object and the background. The most modern approach to image segmentation is deep learning, using models such as convolutional neural networks (CNN) or vision transformers (ViT). However, these approaches require large amounts of training data.

Our goal is to develop reliable methods to detect edges in optical coherence tomography (OCT) scans that require minimal training data. A former NIST report analyzed the effectiveness of edge detection using wild binary segmentation, Haar-like features, wavelet filters, and local polynomial regression. In this project, we adapt the Snake Active Contour and Chan Vese models to segmenting multiple regions within an image, and compare their performances to those of the methods studied previously.

The standard reference material (SRM) 2196 replicates OCT scans with two retinal layers. We also create synthetic datasets that mimic the SRM 2196 data, with known ground-truth edge locations for evaluation. Then, the results of different methods are compared using the bias and standard deviation of thickness estimates and the root mean square error of edge estimates. Additionally, we vary the noise levels and point spread functions across the synthetic datasets to analyze the conditions under which each method performs well.

We find that Snake Active Contour and Chan Vese consistently perform better than the methods studied previously, likely because they are global methods, so they are less sensitive to noise, and they do not assume constant regional intensities.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Akshay Karthik Manimaran

Academic Institution: University of Maryland - College Park

Major: Computer Science

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): I plan to attend graduate school at the University of Maryland aiming to earn a Master's Degree in Computer Science

NIST Laboratory, Division, and Group: Information Technology Laboratory, Division 776, Group

NIST Research Advisor: Adam L. Pintar

Title of Talk: Optimizing an artistic approach to defect detection in advanced semiconductor packages

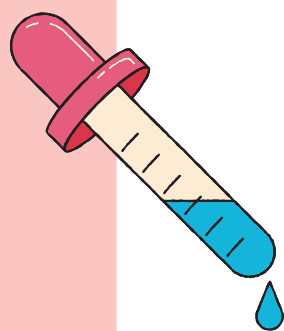
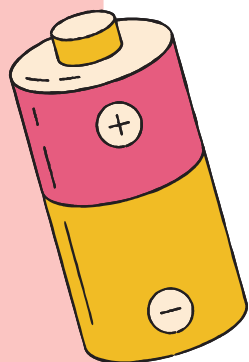
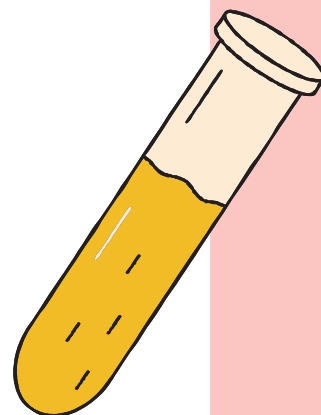
Abstract:

An advanced semiconductor package is essentially a stack of individual microelectronic devices, creating a 3D structure. Stacked architectures can enable performance scaling as Moore's law nears its physical limits, and they are found in commercial electronics such as smart phones and laptop computers. Electrical connections between the layers are required, and through silicon vias (TSVs), which are tall thin holes filled with a conductor such as copper, provide a connection from one side of a silicon substrate to the other. However, when manufactured, they are susceptible to defects such as voids and fractures, which can degrade performance or cause device failure. Because the vias are internal to the 3D structure, X-ray Computed Tomography (XCT) or X-ray Computed Laminography (XCL), which reconstructs 3D volumes from X-ray projection images, is a potential tool for nondestructive inspection of these packages.

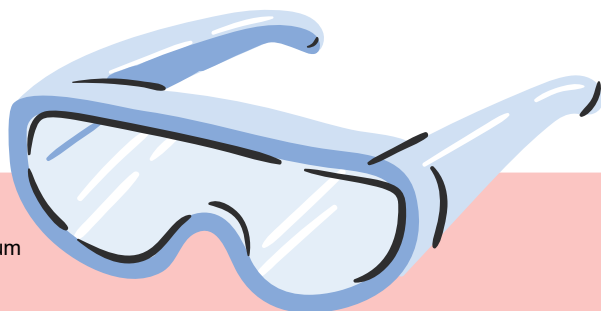
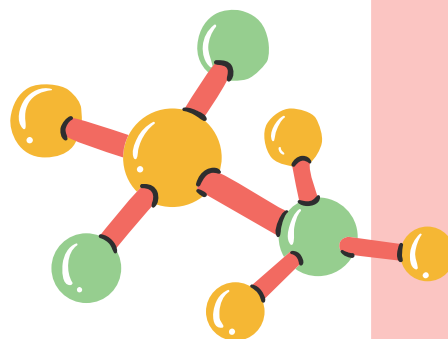
We optimize XCT for inspection through simulation, using the Analytical Radiographic Testing Simulation Tool (aRTist) in this project. We focus on a simple geometric structure consisting of a spherical air void, nested inside a copper cylinder, nested inside a silicon rectangular solid. The goal is to accurately measure the volume of the air void using the data generated by the XCT simulator. Accuracy is affected by XCT acquisition parameters such as the X-ray tube current and image acquisition time. We search for the best settings of the acquisition parameters using Bayesian optimization, which is a sequential search procedure that uses observed measurements of air void size to choose the next combination of XCT acquisition parameters. The presentation will include a detailed description of the full procedure.

An output of the project is a Python application programming interface (API) for controlling aRTist. It

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Iliana Johnson		
Academic Institution: University of Maryland, Baltimore County		Major: Mathematics & Dance
Academic Standing (Sept. 2026): Junior		
Future Plans (School/Career):		Graduate studies in Mathematics or related computing fields
NIST Laboratory, Division, and Group:		Information Technology Lab, Statistical Engineering Division, Statistical Design, Analysis, and Modeling Group
NIST Research Advisor:		Dr. Kristine Gierz, Dr. Hariharan Iyer
Title of Talk:		Validating the Coefficient of Disagreement for Complex Biological Datasets
Abstract: The importance of understanding the heterogeneity of biological measurement is fundamental to the creation of Reference Materials (RMs). For example, characterizing the National Institute of Standards and Technology's (NIST) Human Fecal RM (RM 8048) requires precise multi-omic profiling. While researchers often rely on traditional hypothesis testing, these methods generally provide a binary choice of statistical difference rather than giving an easily interpretable measure of how much samples actually disagree. In order to obtain a more meaningful and practical metric for scientists, the Coefficient of Disagreement (COD) measures biological disagreement based on a probabilistic upper confidence bound at a particular percentile level of a pairwise distance matrix. However, the elements within this matrix are inherently dependent. This pairwise dependence makes exact confidence intervals difficult to calculate, making a rigorous simulation study essential to understand the metric's behavior. To evaluate the practical performance of the COD, we conducted a comprehensive simulation study evaluating the empirical coverage, interval widths, and variance estimation of the COD. By generating generalized distance matrices for both independent and stratified populations, we test exact non-parametric bounds across a family of target percentiles. Furthermore, we compute and test specialized unbiased variance estimators derived from sub-sampled matrices. Through this simulation, we aim to define the boundaries of empirical coverage for the COD and map the mathematical limitations of non-parametric statistics at varying sample sizes. Additionally, we seek to validate the reliability of the determined unbiased variance estimators when correcting for matrix dependence. Eventually, having reliable metrics will make sure that the multi-omic measurements become standardized, and microbiome therapeutics and precision diagnostics will be developed rapidly, precisely, and reproducibly.		



Material Measurement Laboratory 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Material Measurement Laboratory (MML) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Vivia Nguyen (plenary.speaker).- How Many is Too Many: Drug Sensitivity Drifting in Long Passing HG009 Clonal Cell Lines

Bridgette Bidwell (CHIPS) - A Density Functional Theory and Machine Learning Workflow for Point Defects in Semiconductors

Aditi Gali (CHIPS) - Additive-Assisted Electrochemical Deposition for Efficient Indium Recovery from Electronic Waste

Ryan Giang (CHIPS) - Selective Recovery of Indium from E-Waste via Organic Mixed Conductors

Logan Magaha (CHIPS) - CD-SAXS Code Advancements and Round Robin for Development of a New Calibration Standard

Janet Park (CHIPS) - Optimizing High-Resolution DLP-SLA 3D Printing for Microfluidic Prototyping

Christopher Gutowski (CHIPS) - Characterizing HfO₂ and TiN-Gold thin-films using Ellipsometry and X-ray Reflectivity

Salihcan Kremer (CHIPS) - Mechanical Characterization of Through-Glass Vias (TGVs) via Nanoindentation

Ethan Tan (CHIPS) - Characterizing Copper Microstructures for Enhanced Hybrid Bonding Reliability via Nanoindentation

Giorgia Santore (CHIPS) - Formulating epoxy underfill materials for microelectronics packaging

Justin Chen - Identifying Process Windows for Crystalline GaN Growth Using Molecular Dynamics

Isabella Archiello - Using Machine Learning and Atomistic Simulation to Predict Antibody Melting Temperatures

Maria Grishaeva - The Impact of Surface Amino Acid Mutations on the Solubility of NISTmAb

Khanh Nguyen - Effect of lipid PEG-ylation on Interactions and Stability of Lipid Particles with Antimicrobial Peptides

Eleanor Hamby - Measurement Science and Standards for Scale-Out Distributed Pharmaceutical Manufacturing

Amie Zeng - Analysis and Visualization of Rapid Street Drug Measurement Data

Lindsey Walter - Glowing Microbes: Characterizing and Measuring Soil Microbial Communities via Fluorescence

Sophia Yang - Inducible Plasmid Copy Number Systems in Cell-Free and Cell-Based Experiments

Sheling Cai - Machine Learning Classification of PFAS from Liquid Chromatography-Mass Spectrometry Data

Marcos Paulino - Characterization of Oropouche Virus RNA

Julia Januszewski - Shining a Light on Kava: Advanced LC-FLD Method Development for Kava RM Characterization

Julia Tisaranni - Optimizing the Development of Metal-Organic Frameworks Through Autonomous Design

Rachel Lee - Ab Initio Electron-Molecule Scattering Calculations for Methane Using UKRMol+ and ASTRA

Tejasvi Subramanya - Molecular Dynamics Simulation for Water Sorption Effects on Epoxy Electronics Packaging

Siena Iavarone-Garza (CHIPS) - Effect of Semiconductor Packaging Interfaces on the Hygrothermal Response in Polymer Films

Angeline Colunga - Fiber Composition Detection for Textile Sorting via Spectroscopy

Andrew Warrington - Development of Metrological Tools for Next-Generation Body Armor Systems

Andrew Cotto-Rivera - Flexible Armor from Fish: Interlocking Interfaces for Biomimetic Protective Systems

Noah Lee - Wave Propagation and Force Dissipation in Aperiodic Polymer Architected Materials

Reagan Elia - Developing Polyolefin Blend Standards for Recycling

Johanna Zimmerli - Exploration of Effective Delivery of Developed Micro- and Nanoplastic Research Test Materials

Erin Morrison - Broadener-Dependent Oxygen Line Shape Parameters with Exoplanet Atmospheric Significance

Jackson Rockhill - A High-Throughput Workflow for Assessing Sustainable Alloys Developing

Charlie Hsu - Agentic Frameworks in Querying Applications

Priscilla Ye - From Bulk Sampling to Microscopic Characterization of Lithium-Ion Battery Black Mass



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Vivia Nguyen

Academic Institution: University of Illinois at Urbana-Champaign

Major: Molecular and Cellular Biology

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Graduate School or Pharmacy School

NIST Laboratory, Division, and Group: MML / Biosystems and Biomaterials Division / Biomarker and Genomic Sciences Group

NIST Research Advisor: Dr. Zhiyong He

Title of Talk: How Many is Too Many: Drug Sensitivity Drifting in Long Passaging HG009 Clonal Cell Lines

Abstract:

Pancreatic cancer is the third leading cause of cancer-related deaths, and well characterized pancreatic cancer cell lines are essential for cancer research. Drug responses of cell lines may change as cells are passaged, leading to overgeneralization of experimental findings. Combined with inadequate donor consent of current pancreatic cancer cell lines, this raises concerns in accuracy and ethics. NIST Genome-in-a-Bottle consortium has developed the second explicitly consented pancreatic cancer cell line, HG009. The genomic information of the cell line has been extensively characterized. HG009-1D5, HG009-3C4, and HG009-4G9 clonal cell lines were obtained from HG009 cells with each exhibiting distinct morphologies. We evaluated the role of the Wnt signaling pathway, a major pathway in cancer progression, in cell proliferation of HG009's early and late passages. An antagonist and an agonist of the Wnt signaling pathway, ICG-001 and CHIR99021, were used to characterize drug sensitivity of the clonal cell lines. MTT cell viability assays were performed to generate dose-response curves, and cell growth was further confirmed by using Celigo Image Cytometer with treatment of an optimized drug concentration. Confluency of the cells was analyzed following 48 hours of treatment, along with percent inhibition and morphological changes. Additionally, cell migration following drug treatment was evaluated using wound healing assays by measuring gap closure. Early passage 3C4 cells exhibited higher sensitivity to ICG-001 than late passage cells, however there were no significant sensitivity differences between early and late passage 1D5 cells. These findings revealed that after more than 20 passages, the 3C4 clonal cell line exhibited reduced Wnt signaling pathway dependency, while the 1D5 clonal cell line retained similar dependency. These results suggest that heterogeneous populations within the bulk HG009 cell line respond differently to the Wnt signaling pathway inhibitor and indicate that differential clonal expansion within a certain cell line may be the cause of drug sensitivity drifting after extensive passages.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Bridget Bidwell

Academic Institution: Purdue University

Major: Materials Engineering

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Finish a PhD in Materials Engineering

NIST Laboratory, Division, and Group: MML / Material Data Division / Data Science and AI Group

NIST Research Advisor: Dr. Daniel Wines

Title of Talk: A Density Functional Theory and Machine Learning Workflow for Point Defects in Semiconductors

Abstract:

Wide bandgap semiconductors such as GaN, AlN, and SiC are essential materials for modern optoelectronic and power electronic technologies due to their large bandgaps, high breakdown fields, and thermal stability. They are widely employed in LEDs, high-frequency transistors, and high-voltage power electronics. The performance and reliability of these devices are strongly impacted by point defects, which govern carrier concentrations, recombination processes, and electrical conductivity. Hence, understanding the formation energies and electronic properties of point defects is critical for optimizing the performance of these materials. In this work, we aim to determine the formation energies of point defects in these wide band gap materials by combining density functional theory (DFT) with a graph neural network-based machine learning interatomic potential (MLIP). While DFT provides an accurate description of defect energetics, point defect calculations are computationally demanding because they require large supercells and careful treatment of charged defects, and can be difficult to converge. These conditions make exhaustive DFT studies of the large configurational space of defect species, charge states, and concentrations prohibitively expensive. To address this challenge, we propose a workflow in which DFT calculations are first performed for a representative set of common defects, including vacancies, substitutions and interstitials. The resulting dataset of relaxed structures and defect formation energies will then be used to fine-tune a pre-trained MLIP. Once trained, the MLIP can rapidly predict defect energetics for systems that are inaccessible to routine DFT calculations, enabling the exploration of larger, more realistic, supercells and a much broader range of defect configurations at a lower computational cost. We aim to generate a comprehensive and publicly available dataset of defect formation energies and relaxed structures for dopants spanning a broad range of the periodic table, multiple charge states, and various defect configurations.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Aditi Gali

Academic Institution: University of Oklahoma

Major: Chemical Engineering

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Ph.D. in Chemical Engineering at the University of Texas at Austin

NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / and Polymer Processing Group

NIST Research Advisor: Dr. Lucas Flagg

Title of Talk: Additive-Assisted Electrochemical Deposition for Efficient Indium Recovery from Electronic Waste

Abstract:

Indium, a critical mineral essential for nearly all capacitive touchscreens and LCDs, faces severe supply chain vulnerabilities due to a heavy reliance on imports. As the demand for such technology accelerates, profitable recycling methods are necessary to secure a domestic supply and prevent a critical material shortage. To achieve this, traditional hydrometallurgical separation methods often end with electrowinning, which typically utilizes chloride or nitrate solutions that generate toxic gases during operation. Thus, a sulfate-based electrolyte was selected in this work to eliminate environmental hazards. However, electrowinning in sulfate baths tends to produce dendritic, non-uniform metallic deposits that degrade material performance. Therefore, the effects of several chemical additives were studied to refine deposit quality and manage competitive hydrogen evolution. Organic leveling agents and surfactants (such as gelatin, urea, SDS) were utilized to suppress dendritic growth and minimize surface pitting, while buffers stabilized the cathode interface. Electrochemical techniques, including cyclic voltammetry (CV) and chronoamperometry (CA), were employed to evaluate how different additives shifted the reaction potential influenced indium nucleation over time. Faradaic efficiency was calculated to compare additive performance by quantifying indium recovery relative to hydrogen gas evolution. We investigate the deposit morphology, composition, and crystal orientation with a variety of analytical techniques, including optical microscopy, x-ray photoelectron spectroscopy (XPS), scanning electrochemical microscopy (SECM), and grazing incidence wide-angle X-ray scattering (GIWAXS). Ultimately, adjusting these additive concentrations successfully refined the efficiency and microstructure of indium deposition, providing a safer and highly efficient pathway to electronic scrap recycling.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ryan Chinh Giang

Academic Institution: University of California, San Diego

Major: Chemical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Graduate school for chemical engineering or materials science

NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / Polymers Processing Group

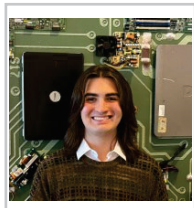
NIST Research Advisor: Dr. Lucas Flagg and Dr. Dilara Meli

Title of Talk: Selective Recovery of Indium from E-Waste via Organic Mixed Conductors

Abstract:

Indium is a critical metal widely used in semiconductor and electronic devices, most notably as indium tin oxide (ITO), a transparent conductive coating essential for liquid-crystal displays (LCDs) and touchscreens. Growing demand for advanced electronics, coupled with limited natural reserves and low recycling rates from electronic waste, has elevated indium to critical mineral status and highlighted the need for efficient recovery strategies. Organic mixed ionic-electronic conductors (OMIECs) are polymers capable of simultaneously transporting ions and electrons. In this study, an n-type OMIEC is investigated as an electrode material for selective indium recovery from electronic waste streams via capacitive deionization (CDI). N-type OMIECs are promising for metal separations because electrochemical reduction promotes cation uptake, enabling selective capture of metal ions such as In^{3+} .

To evaluate this, electrochemical quartz crystal microbalance with dissipation monitoring (EQCM-D) is used to investigate ion uptake of OMIEC-coated electrodes from a flowing indium sulfate solution that simulates an e-waste stream. EQCM-D monitors changes in film mass and viscoelastic properties during electrochemical measurements. Cyclic voltammetry (CV) reveals a reversible redox process associated with ion uptake and release within the OMIEC, indicating reversible electrochemical doping. Ongoing work uses ac-electrogravimetry and electrochemical impedance spectroscopy (EIS) to determine whether the observed charge compensation arises primarily from proton uptake, In^{3+} uptake, or a combination of both by correlating frequency-dependent electrochemical responses with mass transport. This work provides insight into structure-function relationships in OMIEC-based CDI systems and supports the development of scalable, sustainable approaches for critical metal recovery.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Logan Magaha

Academic Institution: Texas State University

Major: Electrical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Graduate Studies, Research & Experience in Semiconductor/Computer Chip Industries

NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / Polymers Processing Group

NIST Research Advisor: Dr. Caitlyn Wolf and Dr. Joe Kline

Title of Talk: CD-SAXS Code Advancements and Round Robin for Development of a New Calibration Standard

Abstract:

As semiconductors become increasingly key to the global economy, the ability to non-destructively quantify their underlying composition and structure at nanometer-scale dimensions calls for new methods of measurement. Critical-Dimension Small-angle X-ray scattering (CD-SAXS) is an ideal method for characterizing these structures. SAXS functions by taking advantage of the elastic scattering that occurs when X-rays collide with the electron clouds of atoms in a sample, where the resulting angles relate to the shape and structures of the material. CD-SAXS rotates the sample about an axis perpendicular to the beam path to gain more detail on the depth of these structures. CD-SAXS being a more uncommon technique has led us to develop Python-based codebases for reduction and analysis of CD-SAXS measurement data for release. As instruments become more advanced, a new reference material that enables calibration to a higher accuracy is required to meet industry needs and is under development at NIST. The calibrant design is a tungsten line grating with a 100nm spacing atop a silicon nitride membrane. My work to improve the reduction and analysis codebases along with characterizing the cross-sectional shape of the SRM using CD-SAXS is essential to its development. To evaluate the effectiveness of the tungsten grating, a round-robin study is being conducted with approximately 35 beamline participants worldwide, consisting of beamlines performing measurements of provided block copolymer films with unknown lamellar spacings and the tungsten gratings to evaluate the accuracy of their current calibration methods and the potential gains for this new calibrant as a future standard reference material (SRM) and help to gauge and bring awareness to the need for a new standard of calibration. My work on this project consists of preparing and distributing the round-robin samples, characterizing data fits of the SRMs, and making improvements and fixes to the code repositories with the goal of a broader public release as a pip package. My presentation will introduce the calibrant design and its impacts, the advances made in the reduction and analysis code, and the future of the project, along with personal contributions and takeaways.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Janet Park

Academic Institution: University of Maryland - College Park

Major: Mechanical Engineering

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** PhD in mechanical/nuclear engineering

**NIST Laboratory,
Division, and Group:** MML / Material Science and Engineering Division / Polymers and Complex Fluids Group

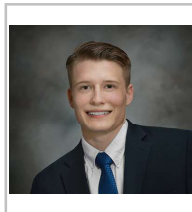
**NIST Research
Advisor:** Dr. Derek Sanchez

Title of Talk: Optimizing High-Resolution DLP-SLA 3D Printing for Microfluidic Prototyping

Abstract:

High resolution Digital Light Processing (DLP) stereolithography (SLA) 3D printing has enabled rapid fabrication of millifluidic and microfluidic devices. It can become an effective prototyping tool for researchers at NIST as several iterations of devices and PDMS molds can be printed and ready for use in a single day. However, layer-by-layer manufacturing introduces wall scalloping and warping, resulting in periodic ridges and rough feature surfaces that deviate from intended CAD geometry and are suboptimal for accurately modeling fluid mixing and device performance. Additionally, feature dimensions, particularly of internal channels, are constrained due to the XY pixel size and Z-layer resolution of the 3D printer hardware.

This project explores layer refinement for the CADworks3D Hyper 50 printer on campus by optimizing printing parameters such as exposure time and power ratio through iterative testing to mitigate scalloping and expand channel size limitations. Layers were refined from the original 100 microns down to 50 microns, and eventually 30 microns, allowing square channels 200 microns in size and circular channels 300 microns in size to be reliably fabricated. The optimized settings were determined via custom Python-based image processing to quantify surface roughness of fabricated devices and features.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Christopher Gutowski

Academic Institution: University of Notre Dame

Major: Electrical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Masters in Engineering

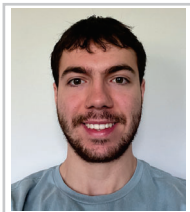
NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Microscopy and Microanalysis Research Group

NIST Research Advisor: Dr. Donald Windover

Title of Talk: Characterizing HfO₂ and TiN-Gold thin-films using Ellipsometry and X-ray Reflectivity

Abstract:

The escalating global demand for high-performance computing and energy-efficient electronics necessitates enhanced process control of novel semiconductor materials capable of reducing leakage current, enhancing thermal stability, and improving process yield. This continuing evolution in materials adoption will be accelerated by using NIST Research Grade Test Materials that both verify theoretical structure models and calibrate characterization instruments prior to widescale material implementation within the semiconductor industry. In following this goal, our research focuses on the uniformity of deposited thin oxide and nitride materials. We characterized wafers deposited with thin-film hafnium oxide, and titanium nitride (deposited with and without gold capping), prepared with atomic layer deposition and ion-beam deposition respectively on 200 nm silicon substrates. Spectroscopic ellipsometry was performed at 120 points on the wafers sequentially to obtain the initial measurement map of the film thickness and implied model structure. These initial thickness model values were then used in confluence with X-ray reflectivity (XRR) to verify film thickness and uniformity of the deposited layers from each type of deposition. We found the inclusion of gold, which was known to form Volmer-Weber “islands” when deposited, provided high variance in structure from wafer to wafer, making this material a challenge to release as an RGTM. On the other hand, HfO₂ proved to have a more uniform and amorphous growth, making it a better candidate. Further research will be conducted on HfO₂ to confirm its viability as an RGTM.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Salihean Kremer

Academic Institution: Purdue University

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Pursue a MS degree in Semiconductors/Controls

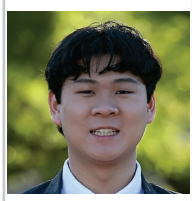
NIST Laboratory, Division, and Group: MML / Material Measurement Science Division / Nanomechanical Properties Group

NIST Research Advisor: Dr. Yvonne Gerbig

Title of Talk: Mechanical Characterization of Through-Glass Vias (TGVs) via Nanoindentation

Abstract:

Through-glass vias (TGVs) are vertical electrical interconnection through a glass substrate and critical components for advanced semiconductor packaging due to low dielectric loss, and superior coefficient of thermal expansion compatibility. TGVs are fabricated by drilling micrometer-sized holes through the glass, metalizing them with copper (Cu) and consecutive heat treatment (annealing). During the fabrication process, high internal anisotropic (direction dependent) stresses are generated within the vias due to the high aspect ratio (depth to diameter ratio) of structure. During the annealing, the polycrystalline Cu filling undergoes recrystallization and grain growth causing changes in grain size and morphology. The resulting residual stresses may vary across the Cu filling quite significantly and can lead to integrity and reliability concerns (Cu protrusion, substrate cracking, delamination of Cu/glass interface). Changes to microstructure and stress state of the Cu filling affect the deformation behavior and associated mechanical properties. In this study, the mechanical properties of TGV test structures (Cu filled vias in fused silica substrate) were evaluated using instrumented indentation (nanoindentation). This is a characterization method to probe the deformation behavior of materials at the microscale by applying a controlled force to a material surface via a probe with defined geometry. The deformation behavior (plasticity) of the Cu filling, which is important of particular interest to the phenomenon of Cu protrusion was characterized by yield strength and creep testing. The spatial variation in mechanical properties of Cu was analyzed by conducting indentation experiments across vias and mapping the measured elastic modulus and hardness. “Mechanical mapping” was also performed on cross-sections of vias to assess potential dependencies on the crystallographic orientation. The presented measurements were conducted at room temperature; they provide baseline data for future work involving testing of TGVs at elevated temperatures to study thermal effects on microstructure and mechanical properties.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ethan Tan

Academic Institution: Purdue University

Major: Electrical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Semiconductor Manufacturing and/or Design

NIST Laboratory, Division, and Group: MML / Material Measurement Science Division / Nanomechanical Properties Group

NIST Research Advisor: Dr. Yvonne Gerbig

Title of Talk: Characterizing Copper Microstructures for Enhanced Hybrid Bonding Reliability via Nanoindentation

Abstract:

In semiconductor manufacturing, advanced packaging explores novel materials, processes, and designs to increase transistor density; one emerging technique is Cu-Cu (copper to copper) hybrid bonded interfaces, which enable vastly higher interconnect density beneficial for applications such as chip stacking. Successful Cu-Cu bonding is dependent on many process-related factors, such surface treatments, bonding environment and parameters of the bonding process itself. However, the microstructure of the Cu substrate heavily influences the bonding performance, as grain size, grain-boundary densities, and twin-boundary densities affect mechanical behavior and electromigration reliability. The plastic deformation and creep behavior of the Cu microstructure are especially relevant to the thermocompression step in the bonding process.

This study evaluates the mechanical properties and associated deformation behavior of different Cu microstructures: fine-grain (FG), nano-twinned (NT), and nanocrystalline (NC) Cu, in the form of films deposited on silicon substrates. For this purpose, comparative instrumented indentation (nanoindentation) tests measure how materials deform at the microscale by applying a controlled load to the surface via probes with a specific tip geometry. Plasticity of the three microstructures was assessed by measuring the yield strength and elastic modulus, while creep behavior was characterized by measuring the indentation creep rate and strain rate sensitivity of the hardness.

This work will inform the subsequent high-temperature characterization of these different microstructures to evaluate their suitability for the hybrid bonding process, especially the mechanical fusion and thermal annealing stages.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Giorgia Santore

Academic Institution: Cornell University

Major: Chemical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Pursue Ph.D. in Chemical Engineering

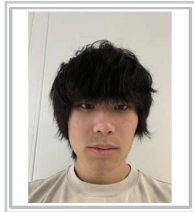
NIST Laboratory, Division, and Group: MML / Material Science and Engineering Division / Functional Polymers Group

NIST Research Advisor: Dr. Andrew Korovich

Title of Talk: Formulating epoxy underfill materials for microelectronics packaging

Abstract:

To meet the exponential growth in microelectronic performance demands seen over the past decade, the packaging and assembly of microchip technology has rapidly evolved. However, the strict specifications of materials required for such specialized applications lead to a complex challenge of trade-offs and competing effects. Capillary underfills are used to fill the space between a silicon die and substrate, distributing stress from thermal expansion mismatch, preventing warpage and breakage as the chip is heated during use, and are critical to advanced techniques such as 3D-stacking and heterogenous integration. Underfill materials are characterized by low viscosity, coefficient of thermal expansion (CTE), and residual stress, which can indicate high performance for this application. To mirror the improvement of new underfill materials in the industry, this project targets the development of a model for use as a material standard for both manufacturing underfill and resulting chip performance. Bisphenol F diglycidyl ether was chosen as the base epoxy because of its low viscosity, along with the diethyl toluene diamine as a curing agent. To produce desired thermal and mechanical properties, spherical, epoxy-functionalized fused silica particles (0.3-1.5 μ m average diameter) were added in particle weight percentages between 50-70%, consistent with current commercial products. The size distribution (monomodal vs. bimodal) of the particles was also investigated, with size ratios 3:1 and 5:1. Additionally, the reactive diluent diglycidyl ether of neopentyl glycol was added in varying proportions between 0-15 mol% to allow capillary flow while retaining needed mechanical properties, which were further quantified using glass transition temperature and modulus. This study investigates the effect of different formulations on capillary flow, as well as the resulting CTE and residual stress after curing within practical timeframes, with the goal developing an optimal formulation that minimizes viscosity, CTE, and residual stress while simultaneously achieving mechanical properties necessary for industrial use.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Justin J. Chen

Academic Institution: Northwestern University

Major: Materials Science and Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Pursue a PhD

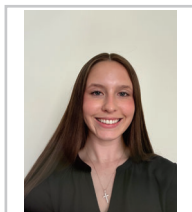
NIST Laboratory, Division, and Group: MML / Material Data Division / Data Science and AI Group

NIST Research Advisor: Dr. Yasir Mahmood and Dr. Lucas Hale

Title of Talk: Identifying Process Windows for Crystalline GaN Growth Using Molecular Dynamics

Abstract:

Wide-bandgap semiconductors such as gallium nitride (GaN) offer superior electronic performance, thermal stability, and breakdown strength compared with conventional silicon, making them attractive for next-generation power electronics and fast-charging technologies. GaN can crystallize into two stable configurations, zinc-blende and wurtzite. These crystalline thin films are conventionally grown using techniques such as sputtering, molecular beam epitaxy and chemical vapor deposition. Experimental studies have shown that the crystalline quality of GaN is highly sensitive to deposition parameters, including the N/Ga flux ratio, impinging particle energy, substrate temperature, and adatom incidence angle. However, the coupled influence of these parameters on crystalline GaN film formation has not been systematically explored. In this study, we use molecular dynamics to simulate molecular beam epitaxy of GaN. The effects of deposition temperature, N/Ga flux ratio, and impinging atom energy on the crystalline quality of the deposited film were systematically investigated. Film quality was quantified using a crystallinity parameter, where a value of 1 corresponds to a perfectly crystalline film at 0 K and a value of 0 corresponds to a fully non-crystalline film. A strong coupled effect of deposition temperature and N/Ga flux ratio on film crystallinity was observed. Higher deposition temperatures generally promoted improved crystalline growth by enhancing adatom mobility and increasing the likelihood of incorporation at favorable lattice sites. Increasing the N/Ga flux ratio also improved film quality by reducing the N vacancy sites, although at the cost of increased N evaporation losses. In contrast, the effect of impinging atom energy was significant only within specific regions of the parameter space explored. The simulation and post-processing workflow developed here can be extended to other material systems for deposition-parameter optimization studies.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Isabella Archiello

Academic Institution: Stevens Institute of Technology

Major: Chemical Engineering

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Ph.D. in Chemical Engineering

**NIST Laboratory,
Division, and Group:** MML / Material Data Division / Theory, Modeling and Simulation Group

**NIST Research
Advisor:** Dr. Christina Bergonzo

Title of Talk: Using Machine Learning and Atomistic Simulation to Predict Antibody Melting Temperatures

Abstract:

Large biomolecules, such as antibodies, have become important platforms for treating disease. The design of monoclonal antibodies that interact with antigens has been slowed by an inability to predict the thermal stability of antibody variable regions. Experimental determination of antibody melting temperatures (T_m) is both time-consuming and resource-intensive, motivating the development of computational approaches that can rapidly rank stability for therapeutic candidates. This project focuses on developing a machine learning framework as well as training data to predict the melting temperatures of antibody variable (Fv). All-atom replica exchange molecular dynamics (REMD) simulations are performed to efficiently sample antibody conformations across a range of temperatures, providing atomistic insight into structural changes associated with thermal unfolding while enhancing conformational sampling relative to conventional molecular dynamics simulations. Structural descriptors derived from these simulations are combined with sequence and structure-based information to develop machine learning models capable of predicting antibody melting temperatures. This work establishes an integrated workflow that combines molecular simulation and machine learning to characterize antibody stability across a range of temperatures, providing physically meaningful descriptors for machine learning model development. The resulting computational framework is intended to improve the prediction of antibody thermal stability and contribute to the development of computational tools that support the design and screening of therapeutic antibodies and advance the AI-readiness objectives of NIST/MML.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Maria A. Grishaeva

Academic Institution: University of Massachusetts, Amherst



Major: Biochemistry and Microbiology

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Graduate school

NIST Laboratory, Division, and Group: MML / Biomolecular Measurement Division / Biomolecular Structure and Function Group

NIST Research Advisor: Dr. Zvi Kelman

Title of Talk: The Impact of Surface Amino Acid Mutations on the Solubility of NISTmAb

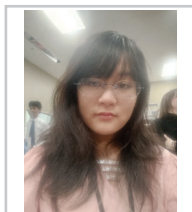
Abstract:

Monoclonal antibodies (mAbs) are proteins that have been isolated from immunoglobulins in the human body's adaptive immune system. mAbs contain antigen-binding regions in their variable domains that can bind to target antigens, and crystallizable regions that can trigger an immune response and destroy antigens. These proteins can be used as drugs to target cells associated with diseases, such as cancer.

NISTmAb is a monoclonal antibody characterized and distributed by the National Institute of Standards and Technology as a reference material. This protein is sold to biopharmaceutical companies, laboratories, and research institutions for applications including development of new analytical techniques and acting as a universal reference standard for research.

Antibody solubility is a major concern for drug developers when choosing the variant or the mutations that are best-suited for the task. The knowledge of protein solubilities provides information regarding shelf time, viscosity, immunogenicity, and benchmarking.

For this project, six individual NIST mAb mutations were chosen using the NISTmAb structure from x-ray diffraction experiments, searching for the surface-exposed positively charged residues, and changing the charge at those residues. The overall goal is to produce these six mutants and then test their solubility. This will be accomplished by transfecting prepared plasmids into Chinese hamster ovary (CHO) cells, allowing the CHO cells to secrete the antibodies, purifying the antibodies from the media, and characterizing the variants.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Khanh Nguyen

Academic Institution: Johns Hopkins University

Major: Biomedical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Industry/PhD

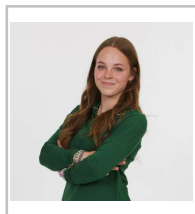
NIST Laboratory, Division, and Group: MML / Biomolecular Measurement Division / Biomolecular Structure and Function Group

NIST Research Advisor: Dr. Ella Mihailescu

Title of Talk: Effect of lipid PEG-ylation on interactions and stability of lipid particles with antimicrobial peptides

Abstract:

Antimicrobial peptides (AMPs) are a promising alternative to antibiotics, with effects like reduced toxicity and decreased induction of bacterial resistance. However, a major challenge is delivering these AMPs to infected tissues effectively. Lipid vesicles, particularly those incorporating polyethylene glycol (PEG)-lipid conjugates, are widely used to deliver these AMPs due to PEGylation's stabilization of these particles. However, the extent to which PEGylation affects vesicle structure and AMP-binding capacity could be further studied. This project investigates DMG-PEG2000's effects on size, polydispersity, and AMP-binding properties of small unilamellar vesicles (SUVs) combined with a POPC:POPG lipid mixture. SUVs prepared with PEG molar fractions at 0%, 5%, 10%, and 20% were characterized by dynamic light scattering (DLS) to determine hydrodynamic radius and polydispersity. Binding of the AMP Dermaseptin to these lipid vesicles was assessed with tryptophan fluorescence spectroscopy at 280 nanometers; results collected were fit to a Langmuir adsorption model to calculate dissociation constants (kD) and number of lipids bound to each peptide (n). Differing density of PEG stabilized the liposomes against aggregation, but increasing the percentage density did not change the binding affinity significantly. Antibacterial activity against E. coli was assessed through minimum inhibitory concentration (MIC) assays with the same PEG series: MIC values remained the same for all except 10% PEG, which showed two-fold improved potency. The results from these methods suggest that PEG-driven changes in vesicle structure, rather than peptide-lipid binding affinity alone, contributes to antibacterial potency across different PEG densities.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Eleanor Hamby

Academic Institution: Binghamton University

Major: Biomedical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Master's Degree in BME | Medical Devices Industry

NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Surface and Trace Chemical Analysis Group

NIST Research Advisor: Dr. Thomas P. Forbes

Title of Talk: Measurement Science and Standards for Scale-Out Distributed Pharmaceutical Manufacturing

Abstract:

Conventional pharmaceutical manufacturing relies on large-scale production of standardized drug dosages for broad patient populations. However, advances in additive manufacturing, including 3D printing and drop-on-demand deposition, have pushed toward decentralized production, creating a more agile approach to address medical emergencies, drug shortages, or when individualized dosing is required. These technologies offer promising solutions by enabling precise, on-demand pharmaceutical production at the point of care (PoC), improving the accessibility, reproducibility, and efficiency of personalized medicine through developments in measurement science and potential standards for automated drug manufacturing. The transition to bedside care requires rigorous evaluation of quality assurance and quality control measures for automated dispensing systems.

This work investigates the capabilities of the I.DOT automated liquid-handling platforms for the accurate dispensing of pharmaceuticals, progressing from small molecule antibiotics to larger proteins and nanoscale liposomal formulations. Levofloxacin and ciprofloxacin printed tablets were quantified via UV-Vis spectroscopy by single-point calibration against a reference standard or by linear least-squares calibration. Dose quantity and content uniformity metrics were evaluated in accordance with USP guidelines. To evaluate potential challenges such as sedimentation, surface adsorption, and aggregation in dispensing larger molecules, fluorescent plate reader analyses of green fluorescent protein (GFP) were conducted, highlighting the importance of mixing protocols. The workflow was subsequently extended to tableting of liposomal formulations. Quality by Design (QbD) principles identified critical material attributes and process parameters with the highest potential risk to liposomal integrity. Fluorescence permeability assays and spin-column purification evaluated liposomal stability under varying conditions. These findings establish a robust framework for automated, point-of-care pharmaceutical manufacturing.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Amie Zeng

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Explore AI/ML, computer vision, and cybersecurity.

NIST Laboratory, Division, and Group: MML / Material Data Division / Data Center and Business Group

NIST Research Advisor: Dr. Zachary Trautt

Title of Talk: Analysis and Visualization of Rapid Street Drug Measurement Data

Abstract:

The growing evolution of street drug supply presents a serious challenge to public health and safety. Addressing this crisis requires not only discovering new ways to rapidly measure drug samples across the country, but also ways to capture the current landscape of drug data through data aggregation, analysis, and visualization. Previous work illustrated individual drug compound and compound co-detection, and conclusions can be made about which individual compounds and combinations most frequently appear in drug samples per month for each region of the United States. To analyze not only the prevalence of individual drug compounds in a given month or year but also trends among the categories of such compounds, we conducted an additional co-detection analysis of the drug categories. This talk presents the details of this methodology and a network graph visualization, which was used to illustrate the relationships between categories and their prevalences. The network graph shows some categories are much more likely to be sampled with certain combinations than others. For example, Opiates are more likely to appear in a sample with Pharmaceuticals than with Phyto cannabinoids. This talk will present several other interesting data visualizations and discuss how my contribution will be implemented in a broader data infrastructure.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Lindsey Walter

Academic Institution: University of Maryland, College Park

Major: Microbiology

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): I plan to complete a PhD and pursue research afterwards either in academia or the public sector.

NIST Laboratory, Division, and Group: MML / Biosystems and Biomaterials Division / Complex Microbial Systems Group

NIST Research Advisor: Dr. Ian Hines

Title of Talk: Glowing Microbes: Characterizing and Measuring Soil Microbial Communities via Fluorescence

Abstract:

Microbiomes are vital to complex life such as humans. The microbiome is comprised of a variety of microorganisms well-adapted to their habitats including environmental niches (i.e., soil and water) and host-associated niches (i.e., human skin and gut). Due to their criticality, microbiome investigations have exponentially increased in recent decades. However, there are few standardizations for microbiome measurements resulting in disparate methods lacking high-confidence validation. Another challenge involves the difficulty in culturing and enumerating microorganisms in the lab, outside their specialized habitats. Traditional methods are limited by time, media bias, and ex situ conditions. To overcome these challenges, two programs were initiated during this SURF internship. First, a culturomics-based workflow was designed and tested with soil samples to characterize microorganisms living in NIST soil. Analysis of the microbial species from the soil microbiomes confirmed the identities for many of these isolates to be microorganisms commonly found in soil. However, a *Glutamicibacter* species that is under-categorized in the literature (i.e., very few sequenced genomes exist) was also isolated. Further categorization of the NIST soil microbiome will be useful in expanding the NIST Microbial Strain Bank (NMSB) and developing methods to better isolate novel microorganisms. Second, a microbial tracking procedure using various microbial cloning protocols was optimized to create fluorescent (“glowing”) bacteria. Fluorescence, including several unique fluorophores, has been successfully incorporated into disparate bacterial species. Optical spectra and cell counts for the various transformants were generated to provide specific signatures correlated to each glowing species. Bacterial dynamics were then measured via flow cytometry in these differentially glowing microbial communities to understand how different species affect each other. The fluorescent toolkit generated here is crucial to assist the community in better validating measurements to identify species-of-interest in complex microbial communities.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Sophia Yang

Academic Institution: University of Maryland, College Park

Major: Cell Biology & Molecular Genetics

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Graduate school

NIST Laboratory, Division, and Group: MML / Biosystems and Biomaterials Division / Cellular Engineering Group

NIST Research Advisor: Dr. Fernanda Piorino and Dr. Samuel Schaffter

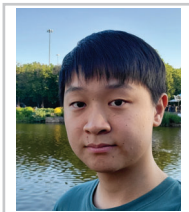
Title of Talk: Inducible Plasmid Copy Number Systems in Cell-Free and Cell-Based Experiments

Abstract:

Biomanufacturing offers the ability to produce a variety of biomaterials. Two possible systems include cells and cell-free systems. Cell-based systems promise inexpensive production on a large scale. Cell-free systems support transcription and translation in a test tube instead of a cell. Cell-free systems can create, control and test genetic circuits unconstrained by cell viability. Both cell and cell-free systems require transforming cells with DNA (termed plasmids) encoding a target biomaterial. However, cell-free systems typically require high-copy-number plasmids to maximize DNA yields, while cells require a lower copy number to minimize toxicity. There is currently not a single plasmid system that can successfully bridge these two biomanufacturing platforms.

To bridge this gap, we used plasmids with inducible copy number. One system we tested was regulated via RNA, and another via protein. We tested each system in two different *Escherichia coli* strains (DH10 & BL21 Star DE3). One strain (DH10) was ideal for plasmid production and extraction to then use in cell-free reactions, while the other (BL21 Star DE3) enabled high protein production. To assess both mechanisms of plasmid regulation, we conducted a number of measurements. We measured the plasmid concentration directly from DH10, and indirectly through green fluorescent protein (GFP) expression in BL21 Star DE3. In BL21 Star DE3, we additionally measured cellular growth via optical density, which allowed us to assess toxicity. Finally, we measured GFP and Pepper expression in cell-free systems to assess how increasing copy number in cells would impact the integrity and quality of the plasmid in cell-free reactions.

To conclude, we established a tunable plasmid copy number system that bridges cell and cell-free platforms. This will improve reliability and simplify workflows in biomanufacturing processes.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Sheling Cai

Academic Institution: Georgia Institute of Technology

Major: Electrical Engineering

**Academic Standing
(Sept. 2025):** Sophomore

**Future Plans
(School/Career):** Graduate School

**NIST Laboratory,
Division, and Group:** MML / Material Data Division / Data Science & AI Group

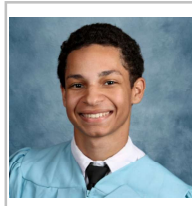
**NIST Research
Advisor:** Dr. David A. Sheen

Title of Talk: Machine Learning Classification of PFAS from Liquid Chromatography-Mass Spectrometry Data

Abstract:

Per- and Polyfluoroalkyl Substances (PFAS), widely characterized as “forever chemicals,” represent an environmental and public health concern due to their persistence and toxicity. There is a need for robust analytical methods to identify and classify these diverse compounds to predict their environmental fate and prioritize regulatory efforts. While high-resolution mass spectrometry remains the gold standard for chemical characterization, traditional data analysis relies heavily on manual feature interpretation, which creates a significant bottleneck that requires extensive expertise and limits scalability. This project addresses that challenge by developing an automated, data-driven machine learning workflow designed to categorize PFAS compounds, leveraging liquid chromatography-mass spectrometry (LC-MS) data to improve both classification accuracy and efficiency.

The methodology utilized a diverse dataset of PFAS LC-MS profiles to train various supervised linear and non-linear machine learning models. Classifications were obtained from a previous NIST study that utilized quantum chemistry calculations and clustering algorithms to group PFAS with similar chemical behavior. This study examines whether the LC-MS profiles can be used to directly reproduce the computationally derived clusters. Because an LC-MS profile is acquired when identifying an environmental PFAS, a model incorporating this data could predict a new PFAS’s behavior as either a surrogate or complement to the quantum chemistry calculations. To ensure strict model reliability and prevent overfitting, performance was rigorously validated using repeated k-fold cross-validation. Furthermore, to provide insight into the algorithmic decision-making process and overcome the traditional “black-box” nature of machine learning, SHAP (SHapley Additive exPlanations) values were calculated. This technique was employed to pinpoint the specific features of the LC-MS data that are most influential in determining PFAS classification.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Marcos Paulino Guzman

Academic Institution: University of Maryland: College Park

Major: Bioengineering

**Academic Standing
(Sept. 2025):** Freshman

**Future Plans
(School/Career):** MS in Biomedical Engineering

**NIST Laboratory,
Division, and Group:** MML / Biomolecular Measurement Division / Applied Genetics Group

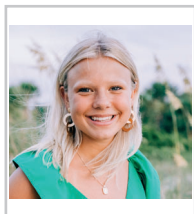
**NIST Research
Advisor:** Dr. Eileen Moran

Title of Talk: Characterization of Oropouche Virus RNA

Abstract:

Oropouche virus (OROV) is a prevalent arbovirus, which has spread throughout South America over time. Oropouche fever, the disease caused by OROV, is clinically under-diagnosed due to its clinical presentation of acute febrile illness, which overlaps with other diseases caused by other common arboviruses in the area. Oropouche fever may potentially be overlooked, emphasizing the need for accurate diagnostics in order to properly quantify and track OROV prevalence in affected communities. Development of diagnostics requires the support of well-characterized materials for diagnostics to be tested, validated, and improved upon.

The Applied Genetics Group at NIST works on various reference materials to aid in developing clinical diagnostics utilizing optimized digital droplet polymerase chain reaction (ddPCR) assays to characterize those materials. This study primarily utilized reverse-transcription ddPCR (RT-ddPCR) to quantify and characterize in vitro transcribed RNA from the OROV S segment of its genome. RT-ddPCR assays were designed by analyzing the S segment RNA sequences of OROV and related reassortant viruses, including Iquitos virus, Madre De Dios virus, and Perdoes virus. Five assays were designed with three predicted to be specific to OROV's S segment, and two assays were designed to detect OROV RNA and its relative viruses' RNA. The assays were then tested to optimize annealing temperatures and test for assay linearity, cross reactivity with human RNA, and residual DNA contamination. By designing RT-ddPCR assays that can detect and characterize the material, this research contributes to pandemic preparedness measures in the event of future OROV outbreaks requiring additional control materials.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Julia Januszewski

Academic Institution: Clemson University

Major: Chemistry

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Graduate studies in analytical chemistry

NIST Laboratory, Division, and Group: MML / Chemical Sciences Division / Organic Chemical Metrology Group

NIST Research Advisor: Dr. Hugh Hayes

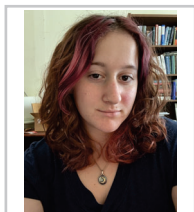
Title of Talk: Shining a Light on Kava: Advanced LC-FLD Method Development for Kava RM Characterization

Abstract:

Kavalactones are a primary class of phytochemicals found in kava (*Piper methysticum*), a botanical traditionally used in the South Pacific Islands for its anti-anxiety and relaxing effects and is now widely marketed as a dietary supplement. While these marker compounds drive the botanical's desired therapeutic properties, analytical characterization remains challenging due to a lack of authentic reference materials (RMs).

To address this gap, NIST is currently developing two natural-matrix RMs for kava to support quality control, product standardization, and experimental rigor. Although liquid chromatography with ultraviolet-visible absorbance detection (LC-UV/Vis) is the industry standard for kava analysis, this project leverages the strong native fluorescence properties of six major kavalactones to develop a highly sensitive LC with fluorescence detection (LC-FLD) method. Development of this LC-FLD method not only improved detection limits compared to UV/Vis but also leveraged stop-flow capabilities to capture complete excitation and emission spectral profiles of the six marker compounds during chromatographic separation. Acquiring these unique spectral profiles provides an additional layer of selectivity, significantly enhancing peak identification and resolution in complex natural product matrices.

This presentation will discuss the development and optimization of the LC-FLD method, which supports the broader effort to establish authentic kava RMs. The development of these kava RMs is essential for enhancing raw material testing, advancing the standardization of kava-containing dietary supplements, and promoting overall consumer health and safety.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Julia Tisaranni

Academic Institution: University of Maryland, College Park

Major: Chemical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Pursue a graduate degree or work industry

NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Materials Structure and Data Group

NIST Research Advisor: Dr. Howie Joross

Title of Talk: Optimizing the Development of Metal-Organic Frameworks Through Autonomous Design

Abstract:

Metal-organic frameworks (MOFs) are highly porous materials consisting of a crystalline network of metal ions and organic linkers. They have shown promise as a material with many applications such as gas storage and separation, catalysis, drug delivery, and much more. In particular, this structure is ideal for the controlled capture and release of gases due to their large internal surface area. However, there is much we don't know about the effects of synthesis parameters on the properties of MOFs. Having this data could accelerate MOF research efforts. By creating a system that tests a multitude of MOF synthesis parameters, a database can be rapidly created. This project aims to do this by automating the synthesis and characterization of MOFs.

Our MOF robot autonomously performs the experiment by designing a plan for the reaction and executing the synthesis. To close the autonomous loop, our AI agent requires materials characterization data. In this talk, we will focus on our efforts to develop automated gas sorption measurements using Fourier transform infrared spectroscopy (FTIR). To achieve this we built a gas handling platform around a custom modified commercial FTIR autosampler. Samples are loaded into the FTIR and exposed to a gas environment of CO₂. An automated system of mass flow controllers and valves control the environment while a gas analyzer measure CO₂ and water concentration, pressure, and temperature. The gas sorption is measured as a function of synthesis parameters used for each sample, and stored in a database. The autonomous platform uses this data to train an active learning model that will find parameters that have yet to be tested and set up a new experiment.

For this project we are using the CALF-20 (Calgary Framework 20) MOF, which has Zn²⁺ as its ionic center, 1,2,4-triazole as its organic linkers, and oxalate ions bridging layers. CALF-20 can be synthesized solvothermally, shows stability in many conditions, and is ideal for gas sorption. We alter the synthesis parameters from those described in literature and measure the variation in gas sorption.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Rachel Lee

Academic Institution: The Cooper Union

Major: Chemical Engineering

**Academic Standing
(Sept. 2025):** Junior

**Future Plans
(School/Career):** Pursue a PhD in Chemistry

**NIST Laboratory,
Division, and Group:** MML / Material Data Division / Theory, Modeling, and Simulation Group

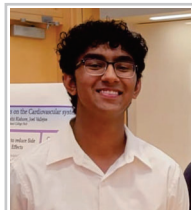
**NIST Research
Advisor:** Dr. Thomas C. Allison and Dr. Siddhartha Chattopadhyay

Title of Talk: Ab Initio Electron-Molecule Scattering Calculations for Methane Using UKRMol+ and ASTRA

Abstract:

Electron collisions with molecules are fundamental to many areas of physics and chemistry, including plasma processing, semiconductor manufacturing, and atmospheric chemistry. To model these processes, accurate electron-molecule scattering cross sections, which describe the probability of elastic and inelastic collision processes over a range of electron energies, are required. While cross sections can be measured experimentally, theoretical calculations provide insight into the underlying collision dynamics and supply data where measurements are difficult to obtain or unavailable. Specifically, in the low energy regime where the scattering electron interacts strongly with the molecular potential, accurately accounting for target-state polarization and electron correlation effects is essential for obtaining reliable scattering cross sections and meaningful agreement with experimental results.

In this project, low energy electron scattering calculations were conducted for methane (CH₄) using the UKRMol+ and ASTRA electron-molecule scattering packages. CH₄ was used as the primary benchmark species due to its relatively simple electronic structure and the availability of published experimental and theoretical cross sections for comparison. A series of calculations were performed to investigate how different physical and numerical approximations influenced the calculated results. By systematically varying the treatment of target-state polarization, electron correlation, active spaces, and scattering model parameters, the role each parameter played in determining the accuracy and convergence of the calculated integral elastic and inelastic cross sections was examined. The methodology developed for CH₄ will provide the foundation for future studies of more complex systems, such as tetrafluoromethane (CF₄), a PFAS gas used in plasma etching. Through this work, quantum scattering calculations with different degrees of electron correlation were conducted to predict electron-molecule scattering cross sections, which will enable the systematic production of scattering data of a wide range of molecules.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Tejasvi Subramanya

Academic Institution: University of Maryland

Major: Bioengineering

Academic Standing Junior
(Sept. 2025):

Future Plans Masters Degree in Computational Biology
(School/Career):

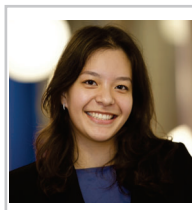
NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / Functional Polymers Group

NIST Research Advisor: Dr. Ryan Nieuwendaal and Dr. Frederick Phelan Jr.

Title of Talk: Molecular Dynamics Simulation for Water Sorption Effects on Epoxy Electronics Packaging

Abstract:

As traditional transistor scaling approaches practical limits, the semiconductor industry is increasingly shifting from conventional two-dimensional layouts toward advanced three-dimensional packaging architectures to improve device performance. While these architectures increase device density and functionality, they introduce critical reliability challenges related to heat generation, moisture uptake, and signal loss. Cross-linked epoxy polymers are widely used in these systems for insulation, adhesion, and mechanical support; however, absorbed moisture can detrimentally alter their dielectric behavior and long-term performance. In this work, all-atom molecular dynamics simulations using the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) package are employed to investigate how water sorption influences the properties of cross-linked epoxy networks, specifically their dielectric behavior. The polymer matrix is modeled using a 2:1 stoichiometric molar ratio of diglycidyl ether bisphenol F epoxy monomer to diethyltoluenediamine crosslinker. Two independent ~5,000-atom systems were evaluated: a non-hydrated (dry) control and an identical network containing 0.5% water by weight. For the molecular dynamics workflow, both systems were equilibrated into a melt state at 800 K under an isothermal-isobaric (NPT) ensemble, then cooled at 100 K/ns through the glass transition down to 100 K. Density-temperature curves generated during cooling were used to calculate the glass transition temperature (T_g). To characterize the materials at intermediate state points, canonical (NVT) ensemble runs were performed to analyze system dynamics, non-equilibrium molecular dynamics (NEMD) was used to evaluate structural moduli, and the Materials Design Analysis and Simulation Platform (MAPS) Dielectric Tool was applied to capture dielectric constants and loss spectra. Ultimately, comparing these replicated dry and hydrated networks provides critical molecular-level insights into moisture-driven performance degradation in next-generation semiconductor packaging.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Siena Iavarone-Garza

Academic Institution: University of Maryland, College Park

Major: Electrical Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Graduate School for Semiconductors or Microelectronics

NIST Laboratory, Division, and Group: MML / Material Science and Engineering Division / Functional Polymers Group

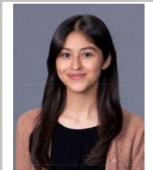
NIST Research Advisor: Dr. Polette Centellas

Title of Talk: Effect of Semiconductor Packaging Interfaces on the Hygrothermal Response in Polymer Films

Abstract:

Epoxy coatings are used to provide mechanical support, electronic insulation, and environmental protection in semiconductor packages, such as flip chip and wire bonded assemblies. Elevated humidity or temperature conditions cause cured epoxy layers to expand or contract more than the substrates they protect, creating residual stresses which can cause packages to warp, and in extreme cases delaminate. Understanding how residual stress and moisture uptake evolve during hygrothermal cycling in packaging films will improve predictive models and enable enhancements in semiconductor performance, miniaturization, and cost efficiency.

This work presents a characterization study of the interfacial layer between an epoxy coating and packaging substrate. A silicon wafer substrate is prepared using four distinct commercial processing methods: (1) UVO cleaned, (2) gold-sputtered, (3) 3-Glycidoxypyltrimethoxysilane (GTMS), and (4) Hexamethyldisilazane (HMDS). An industrially-relevant model epoxy is then coated on each substrate and thermally cured under a unified profile. We employ an ellipsometer to measure the dimensional expansion of the epoxy coating under varying hygrothermal conditions to characterize the moisture diffusivity, saturated moisture content, and coefficient of thermal expansion (CTE). MatLab is used to calculate the moisture diffusivity and saturated mass of films at different humidity cycles. The CTE values are cross-validated using a thin film curvature technique on a NIST custom-built stress bench. The experimental framework also incorporates microscope-based image processing using ImageJ to verify the substrate thickness measured in ellipsometer experiments. These findings highlight the critical role that interfacial layers play in dictating thermomechanical properties and moisture kinetics in semiconductor packaging polymers.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Angeline Colunga

Academic Institution: Texas A&M University, College Station

Major: Materials Science & Engineering

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Industry - Corrosion Career Pathway

NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Security Technologies Group

NIST Research Advisor: Dr. Katarina Goodge and Dr. Amanda Forster

Title of Talk: Fiber Composition Detection for Textile Sorting via Spectroscopy

Abstract:

Only about 15% of textiles get reused or recycled today, and scaling that figure will depend on sorting systems that can automatically identify fiber content as garments move through collection and processing. Near-infrared (NIR) spectroscopy is often used as it offers fast, non-destructive classification without sample preparation. But real-world garments introduce complications. Dyes, finishes, core-spun yarns, and fiber blends all distort the NIR spectral signature, which can lead to misrecognition, incomplete classification, or outright failure to return anything at all. While various analytical techniques are being applied to this problem, the lack of well-characterized reference materials with known provenance continues to limit validation of complex sorting algorithms.

To bridge this gap, NIST released the Near-Infrared Spectra of Origin-defined and Real-world Textiles (NIR-SORT) dataset—NIR spectral fingerprints of 113 diverse fabrics, spanning pure and blended fibers as well as real-world pre- and post-consumer textiles. NIR-SORT provides a critical resource for manufacturers of NIR-based sorting systems to test and validate their algorithms, enhancing the performance and reliability of their technologies. In this work, the influence of dye composition on near-infrared, mid-infrared, and visible spectral signals for cotton substrates is explored, and data is collected and evaluated for a future version of NIR-SORT. To explore the role of dye on interferences in fiber classification, 106 fabric samples with the same fiber content and varied dye composition and color were measured to support a continuous mapping across the color spectrum. By establishing composition – spectral response relationships, this research aims to provide foundational principles for dye- and blend-tolerant classification algorithms that support scalable, accurate textile sorting for a circular economy.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Drew Warrington

Academic Institution: University of Delaware

Major: Mechanical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Seeking to begin a PhD program in Mechanical Engineering Fall 2027.

NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Security Technologies Group

NIST Research Advisor: Dr. Amanda Forster

Title of Talk: Development of Metrological Tools for Next-Generation Body Armor Systems

Abstract:

Traditional body armor systems position bulky, rigid plates over critical areas of the body. While effective, these plates leave sizeable regions unprotected and can restrict free movement of the user. Flexible, fabric-based armor can provide greater coverage, but more limited protection. Splintered efforts across industry and academia have sought to produce a new generation of flexible armor systems, incorporating the benefits of both rigid and flexible body armor systems. Common across these approaches is a mimicry of reptile scales, overlapping small rigid elements mounted to a soft substrate. The unique geometries and structures of this new class of hybrid armor impedes direct comparison of performance using existing standards.

To investigate new metrological tools and the overall understanding of a prototype scale-based armor system's performance, the project for this summer was split over two thrusts. First, developing a Brazilian-disc style test of the prototype scales. In addition, investigating novel substrate materials with meso-scale architectures for efficacy of scale attachment and system performance. To conduct the Brazilian disc experiments, 3D printed plastic and ceramic scales were fabricated, speckled and mounted into a load frame. Digital image correlation was performed to measure displacement fields during quasi-static compression, which are used to evaluate mechanical properties and failure mechanisms of the individual scales. Further, dynamic stab testing was conducted at the system level to relate component-level design properties to system-level performance. This high-level characterization lays the groundwork for future standards and metrologies that can effectively evaluate the structure-property relationship in multicomponent complex architectures for ballistic protection and impact mitigation hybrid systems.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Andrew J. Cotto-Rivera

Academic Institution: Washington and Lee University

Major: Engineering, General

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Pursue graduate studies in mechanical engineering

NIST Laboratory, Division, and Group: MML / Material Measurement Science Division / Security Technologies Group

NIST Research Advisor: Dr. Michael Riley

Title of Talk: Flexible Armor from Fish: Interlocking Interfaces for Biomimetic Protective Systems

Abstract:

Ballistic and edged weapons pose a growing safety threat for first responders and law enforcement officers. Conventional armors use lightweight, high-strength synthetic fibers against lower-level threats and rigid plate systems made of ceramic or steel against severe threats. The former offers greater wearability at the cost of durability, and the latter offers greater protection at the cost of mobility. The balance between flexibility, protection, and weight remains a key challenge in designing next-generation armor systems.

Prior commercial armor designs sought to combine rigid and fiber armors through scales attached to a flexible backing, but these systems suffered delamination between the layers in normal use conditions. To mitigate this potential issue, a mechanically interlocking composite design with soft and stiff components inspired by fish scales was investigated for its stab impact resistance and potential as a more mobile alternative to hard plate armor systems. Factors including the physical interface between soft and stiff components, materials used, and geometry of the stiff scales and soft substrate were investigated to optimize the design. Bioinspired interlocking features include two tab designs, a dovetail-type and suture-type, for insertion into a solid thermoplastic polyurethane (TPU) substrate which balanced flexibility and retention. In this SURF project, tolerances and tab design were varied to optimize the mechanical link between the substrate and the scale.

The adhesion was investigated with digital image correlation (DIC) techniques used in conjunction with universal test machine (UTM) procedures and a drop tower to measure surface deformation of these materials at the scale-substrate interface, their force-displacement curves, the coefficients of friction between materials, full-field geometry data, and their impact resistance. These tests are being used to validate a finite-element model created by our partners at the University of California-Berkeley to support further exploration of bioinspired armors for improved mobility without compromising strength.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Noah Lee

Academic Institution: Swarthmore College

Major: Engineering and Computer Science

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Graduate school or industry

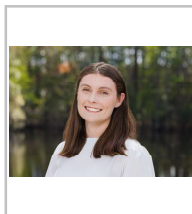
NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / Functional Polymers Group

NIST Research Advisor: Dr. Marcos Reyes-Martinez

Title of Talk: Wave Propagation and Force Dissipation in Aperiodic Polymer Architected Materials

Abstract:

Architected polymeric materials offer lightweight protection against impact events. It is known that the topology of an architected material determines both its quasi-static and dynamic mechanical responses. While periodic frameworks like honeycombs feature easy fabrication and predictable behavior, their translational symmetry can introduce stress concentrations and undesirable paths for stress wave propagation. Alternatively, aperiodic designs answer these drawbacks. Aperiodicity is commonly seen across structures in nature, such as in tree cross-sections and the microscopic structure of mother of pearl. Despite the remarkable mechanical properties of these natural materials, the design rules for aperiodic structures are not well-understood. In this work, we study the mechanical properties of aperiodic systems by focusing on the impact responses of two-dimensional aperiodic strut-networks. Our model system consists of strut-based lattices of a family of aperiodic monotiles that can tile a two-dimensional plane with no translational symmetry. Four different monotile geometries are chosen and compared against a stochastic foam sample of identical density and cell count. Their quasistatic elastic properties are characterized by uniaxial compression and their dynamic mechanical responses are studied using drop-mass impact experiments. During impact experiments, the stress wave propagation is imaged using photoelasticity and high-speed videography. We capture the transmitted forces as a function of time using a dynamic load cell placed under the impacted sample. We observe that aperiodicity scrambles the propagating front of the stress wave, resulting in a dramatic reduction in both propagation speed and the peak force transmitted. Interestingly, slight changes in the shape parameter within the aperiodic monotile family studied can have detrimental effects on the peak force reduction and wave propagation speed. We explain the differences observed by modeling the efficiency of wave conversion at junction points. Our results are critical in informing ongoing work on the creation of a computational model for the design of new aperiodic structures with tailored and predictable mechanical responses.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Reagan Elia

Academic Institution: University of North Florida

Major: Chemistry

**Academic Standing
(Sept. 2025):** Senior

**Future Plans
(School/Career):** Graduate School for Chemistry

**NIST Laboratory,
Division, and Group:** MML / Materials Science & Engineering Division / Polymer Processing Group

**NIST Research
Advisor:** Dr. McKenzie Coughlin

Title of Talk: Developing Polyolefin Blend Standards for Recycling

Abstract:

This research seeks to develop a set of new polyolefin blend Research Grade Testing Materials (RGTMs) including pure polyethylene, pure polypropylene, and two blends for quantitative testing applications. Polyolefins, such as polyethylene and polypropylene, make up the largest share of the plastics waste stream, however, their chemical and physical property similarities make them difficult to sort. Thus, recycled streams are typically mixtures of polyolefins with unknown compositions, possibly leading to undesirable mechanical properties of recycled plastic products. There are several analytical methods to detect contamination in recycled plastics, however, they frequently disagree with each other. Furthermore, there is little agreement on which analytical method and procedure should be used. In this work, polyethylene and polypropylene blends of varying concentrations were made in a twin-screw extruder process line to mimic a bottle and cap recycling stream. Homogeneity of blends was evaluated using microscopy and used to inform processing procedures. Blend composition was evaluated and characterized using Fourier transform infrared spectroscopy, Raman spectroscopy, differential scanning calorimetry, and high-temperature size-exclusion chromatography. To conclude this project, blends will be sent out for inter-lab study to confirm reproducibility. Overall, this research and creation of four new RGTMs will enhance recycling capabilities by enabling quantification of unknown recycle compositions.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Johanna Zimmerli

Academic Institution: Moravian University

Major: Chemistry

Academic Standing (Sept. 2025): Senior

Future Plans (School/Career): Graduate school in analytical chemistry

NIST Laboratory, Division, and Group: MML / Materials Measurement Science Division / Nanomaterials Research Group

NIST Research Advisor: Dr. Tae Joon Cho

Title of Talk: Exploration of effective delivery of developed micro- and nanoplastic research test materials

Abstract:

As indicated by the name of this institute, NIST, measurement science is a core research focus for our organization. Within this field, developing reference materials is a fundamental activity that enables researchers to conduct critical studies on physicochemical properties, environmental impacts, and interactions with biological entities. The production of these materials requires a progressively connected workflow. It encompasses not only the initial material preparation but also final delivery to end users, including formulation, bottling, measuring key properties, verifying reproducibility, evaluating product homogeneity, and establishing standard documentation such as operation protocols. Our group is currently developing a micro- and nanoplastics (MNPs) Research Grade Test Material (RGTM). MNPs are defined by their size with microplastics ranging from 5 mm to 1 mm and nanoplastics being smaller than 1 μm , according to ISO/TR 21960:2020. Validated methods and protocols are essential for accurate chemical analysis, including identification and quantification of MNPs as well as exposure and risk assessments. For MNP-related metrology development, MNP test materials designed to incorporate real-world MNP properties would be the most necessary prerequisite to conduct accurate secondary MNP physicochemical characterization and associated risk assessment. We have already completed the MNP preparation phase using cryomilling methods and are now advancing through the formulation and bottling stages. This summer, my project focuses on conducting lyophilization (freeze-drying) tests as an effective formulation strategy. To achieve this, I prepared a total of 12 distinct dispersion types, varying by dispersing media and concentration. My work involves performing the freeze-drying process on each dispersion, reconstituting the lyophilized materials, and analyzing the particle size distribution before and after the process using laser diffraction. Through these systematic steps, I aim to establish the optimal vacuum freeze-drying conditions, thereby contributing to a successful transition to the subsequent bottling stage.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Erin Morrison

Academic Institution: University of Maryland, College Park

Major: Applied Mathematics

**Academic Standing
(Sept. 2025):** Freshman

**Future Plans
(School/Career):** Likely Graduate School

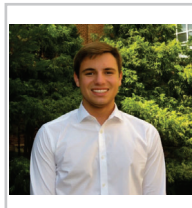
**NIST Laboratory,
Division, and Group:** MML / Chemical Sciences Division / Optical Measurements Group

**NIST Research
Advisor:** Dr. Erin Adkins

Title of Talk: Broadener-Dependent Oxygen Line Shape Parameters with Exoplanet Atmospheric Significance

Abstract:

Spectroscopic reference databases provide line shape parameters with pressure, temperature, and broadener dependences. Traditionally, these databases have focused on broadening gases relevant to Earth's atmosphere. Consequently, they have limited applicability to exoplanets with hydrogen and helium dominant atmospheres. In this work, we collected and analyzed cavity ring-down spectra at a range of pressures for several lines in the oxygen A-Band for oxygen in both helium and hydrogen - helium mixtures. Analysis of these spectra resulted in hydrogen and helium line shape parameters that can be used to populate spectroscopic reference databases. To investigate the impact these parameters have on exoplanet atmospheric simulations, we developed a tool using a series of existing python packages to calculate oxygen molecular cross sections for an exoplanet's environmental conditions (pressure, temperature, and atmospheric broadeners). This tool was used to conduct a sensitivity test comparing the cross sections for primordial and helium-enriched exoplanet atmospheres calculated using hydrogen and helium line shape parameters and those calculated using oxygen and air parameters.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Jackson Rockhill

Academic Institution: University of Maryland- College Park

Major: Materials Science and Engineering

Academic Standing (Sept. 2025): Sophomore

Future Plans (School/Career): Attending graduate school and continuing to explore research interests

NIST Laboratory, Division, and Group: MML / Materials Science and Engineering Division / Thermodynamics and Kinetics Group

NIST Research Advisor: Dr. James Zuback

Title of Talk: A High-Throughput Workflow for Assessing Sustainable Alloys Developing

Abstract:

The NIST System for Additive Manufacturing Alloy Development (SAMAD) is a unique laser-based directed energy deposition (DED) system in which metal powders are melted coaxially with a laser beam. Fast-actuating electrostatic powder feeders allow for the rapid deposition of different alloy compositions through in-situ powder mixing. This capability makes SAMAD a well-suited tool for developing impurity tolerant alloys for recycling applications and reducing the reliance on critical minerals through strategic alloy design. However, successful DED deposits require careful consideration of many tunable variables like laser power and distribution, material properties, scanning speed, powder flow properties and carrier gas flow rate.

This project aims to develop an efficient, high-throughput workflow with SAMAD by studying the process parameters needed to deposit material with the target composition and acceptable track geometry. An in-house load cell device was constructed to measure powder flow as a function of time. Multi-track deposition experiments were then designed in which track geometries and alloy compositions were tightly controlled through process parameter adjustments. Track geometries were evaluated qualitatively with light optical microscopy and quantitatively using laser confocal microscopy and digital image correlation. Material compositions were measured by a scanning electron microscope equipped with energy dispersive spectroscopy. It is shown that the fast switching of parameters in SAMAD can be exploited to deposit single tracks with in-situ variations in track geometry and composition, whereas traditional approaches are limited to uniform parameters within a single track. The developed workflow effectively streamlines sustainable alloy development by reducing the number of experiments and samples needed to assess material composition and process parameter combinations.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Charlie Hsu

Academic Institution: University of Notre Dame

Major: Computer Science

Academic Standing (Sept. 2025): Freshman

Future Plans (School/Career): Industry or Graduate School

NIST Laboratory, Division, and Group: MML / Material Data Division / Data Science and AI Group

NIST Research Advisor: Dr. Lucas Hale

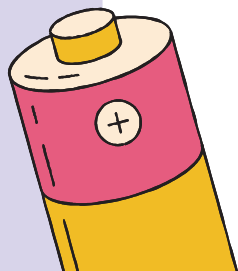
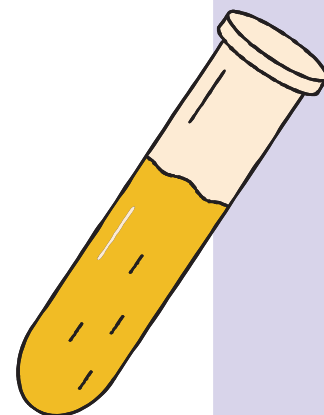
Title of Talk: Agentic Frameworks in Querying Applications

Abstract:

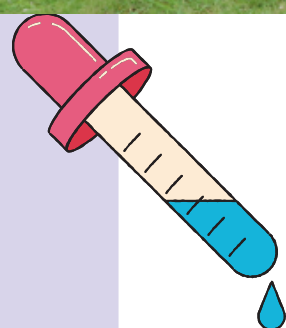
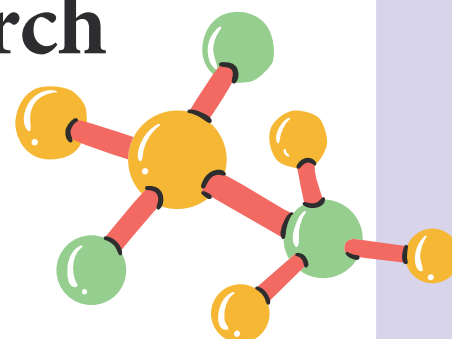
The rapid acceleration of computational power has led to an unprecedented increase in the public distribution of scientific data. As many of these datasets have embraced FAIR (Findable, Accessible, Interoperable, and Reusable) principles, there is a growing opportunity to further streamline how users interact with these compliant sources. Given that FAIR-compliant databases often employ diverse architectures and query languages, Yabadaba was developed as a universal wrapper to complement these systems. By providing an abstraction layer over varying FAIR-compliant databases, Yabadaba acts as an assistive tool that further enhances data accessibility for the end-user. Crucially, the integration of an agentic framework expands this access, allowing users regardless of their technical background to efficiently retrieve and handle data. This project focuses on using this framework to automate and optimize the querying process, adding a layer of intelligent orchestration across these structurally diverse environments.

The implementation centers on a Model Context Protocol (MCP) server, which provides the agent with a specialized toolkit for style enumeration, schema retrieval, handbook acquisition, and parameterized querying. To facilitate a user-centric interface, this architecture was integrated with an Open WebUI instance and connected to the NIST rChat server. Central to the system's efficacy was the iterative development of a specialized agent skill and a meticulously refined system prompt, both of which were engineered to guide the agent through complex, multi-step/recursive retrieval workflows.

Preliminary evaluations indicate that the agent exhibits high operational capacity when provided with comprehensive context; notably, the systemic inclusion of database schemas and handbooks resulted in a statistically significant increase in query success rates. These findings suggest that context-aware agentic frameworks can substantially reduce the technical overhead required for users to navigate complex, multi-format experimental databases.



NIST Center for Neutron Research 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

The NIST Center for Neutron Research (NCNR) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Reece Tippery (plenary.speaker).- Evaluation of Droplet Breakup and Mixing in a Millifluidic Droplet Generator

Amanda Rosario Rivera - Stopped-flow SANS Analysis for Early-stage Kinetics of Two Pharmaceutically Relevant Model Systems

Zehra Syeda - Effects of pH and Ionic Strength on the Structure and Stability of Food Proteins

Harrie Ha - Simulating the Effects of Charged Lipids on Bilayer Area Compressibility

Aanya Tiwari - Techniques to Visualize and Quantify Monoclonal Antibody Flexibility from Simulations

Lydia Bullock - Building the Next Generation of NMR Software for Polarized Neutron Scattering Instruments

Henry Pires-Tolsen - Analyzing Magnetic Properties of Chemically-tuned Nickel Compounds

Carina Jacobson - A Scientific Wingman: AI Co-pilot for Triple-axis Spectrometer Users at the NCNR

Aditya Purohit (CORE) - TASCopilot: Architecture of an AI Research Assistant for Triple-Axis Neutron Scattering at NCNR



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Reece Tippet

Academic Institution: Purdue University

Major: Materials Science and Engineering

Academic Standing (Sept. 2026): Graduated

Future Plans (School/Career): PhD in materials science at the University of Minnesota

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

NIST Research Advisor: Olivia Haider

Title of Talk: Evaluation of droplet breakup and mixing in a millifluidic droplet generator

Abstract:

The development and study of commercial soft matter formulations is challenging because they often contain many components making the phase space large. Optimizing product performance requires exploration of this phase space, but this is a time-consuming endeavor. Millifluidic droplet generation devices offer a platform for the rapid and automated production of discrete droplet samples along a concentration gradient and can be integrated with in-line characterization techniques, providing high-throughput characterization of the droplets. This method has been successfully implemented for the characterization of a variety of complicated polymeric and colloidal systems. However, for higher viscosity systems the mixing induced by droplet breakup in these low Reynolds number flows is reduced, producing insufficiently mixed droplets that are susceptible to splitting and coalescence downstream. This work aims to investigate the operating parameters under which these undesirable phenomena can be avoided and to evaluate methods for enhancement of mixing after droplet breakup. To do so, an optical imaging and image analysis system is developed and used to study droplets of dyed glycerol solutions to evaluate the impact of component viscosity on droplet dimensions and mixing quality. An in-line UV-vis spectrometer is also integrated to evaluate the concentration of dye in each droplet providing insight into the quality of the concentration gradient achieved. These techniques will allow for the definition of operating parameters under which consistent well-mixed drops of known composition can be produced before being characterized with small-angle neutron scattering.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Amanda S. Rosario Rivera

Academic Institution: University of Puerto Rico at Mayagüez

Major: Chemical Engineering

Academic Standing (Sept. 2026): 4th year

Future Plans (School/Career): Fall semester CO-OP at Eli Lilly PR; post-graduation, pursue a PhD in Chemical Engineering

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

NIST Research Advisor: Dr. Chelsea Edwards, Dr. Ryan Murphy and Dr. Yun Liu

Title of Talk: Stopped-flow SANS analysis for early-stage kinetics of two pharmaceutically relevant model systems

Abstract:

Pairing a stopped-flow mixing sample environment with small-angle neutron scattering (SANS) enables the characterization of early-stage kinetics by minimizing the time between mixing and measurement. This in-line mix-SANS approach was recently applied to measure the nano structural changes in pharmaceutical systems: bovine serum albumin (BSA) solutions and lipid nanoparticle (LNP) formulations after mixing. In this project we selected data analysis tools applicable to analyzing datasets to obtain time dependent $I(Q)$ information from the raw scattering data. The BSA experiments aimed to measure the exchange kinetics of labile hydrogens into deuterium (HDX) after mixing BSA in water with deuterium oxide (D₂O). Our data analysis demonstrates that HDX is measurable with stopped-flow SANS even in a 1–5 minute timescale. This allowed the calculation of the time-dependent number of exchanged deuterons and determine the exchange time constant for solutions with different BSA concentrations. For the LNP data, we extracted the first several minutes of $I(Q)$ evolution after the initial precipitation step used to generate NIST research-grade test material (RGTM) 10240 (empty LNPs without RNA) and present our preliminary observations. Our analysis demonstrates the utility of stopped-flow SANS measurements for pharmaceutical research and provides a framework for analyzing future mix-SANS data.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Zehra Syeda

Academic Institution: University of Maryland, College Park

Major: Bioengineering

Academic Standing (Sept. 2026): Junior

Future Plans (School/Career): Medicine and Biomedical research

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

NIST Research Advisor: Susana Teixeira and Thomas Cleveland

Title of Talk: Effects of pH and ionic strength on the structure and stability of Food Proteins

Abstract:

Food proteins are exposed to a range of chemical and physical environments during production, processing, storage and digestion. This impacts critical properties such as emulsion stability, taste, digestion, and allergenicity. With increasing demand for sustainable protein-rich food and beverages, there is a need to establish measurement capabilities that access the effect of such environments. Given the complexity of food samples, containing polydisperse and multicomponent ingredients, multimodal measurements are often necessary to support data fitting and interpretation. Deconvoluting such effects on individual components strongly relies on reference data from simplified systems, from which advanced protein structural models can be designed.

Complementary small angle scattering studies of protein solutions using light, X-ray and neutrons are very powerful in this context, covering a broad range of sizes and sample concentrations. Data were collected and analyzed for food protein solutions prepared in a range of pH and ionic strength conditions, with the goal of obtaining reference data and structural models. This presentation will discuss structural models calculated using different methods, and their corresponding fit to the experimental data. The results will further support future studies of the effects of pressure, temperature and other stresses, relevant to food protein processing and engineering.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Adriana S. Montes Lopez

Academic Institution: Columbia University in the City of New York

Major: Chemical Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): PhD in Biotechnology or working in the biotechnology industry

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

NIST Research Advisor: Dr. Liz Kelley and Dr. Ryan Murphy

Title of Talk: Understanding the mechanical instability of model lipid-based drug solutions

Abstract:

Lipid-based nanoparticles (LNPs) are essential vehicles for delivering fragile therapeutics, such as chemotherapy drugs or messenger RNA, safely and directly into target cells. Following their role in the success of cancer treatment and vaccines, improving LNP manufacturing and distribution has become a primary focus within the biopharmaceutical industry. While incredibly useful, LNPs are chemically and thermodynamically unstable and prone to aggregation, fusion, and leakage over time. To mitigate this degradation, LNPs are stored at ultra-low temperatures (between -20°C to -80°C), creating distribution and storage challenges. Furthermore, mechanical stress during manufacturing and transport can induce similar structural instabilities. Understanding how the characteristics and behavior of these formulations change under physical stress is fundamental to standardizing their manufacturing and ensuring global accessibility. To address this challenge, this project uses model LNP drug solutions to explore how different mechanical stresses impact the stability of the formulations. By identifying the specific effects of shear versus interfacial stresses, this work aims to develop systematic strategies to mitigate degradation, optimize manufacturing and predict LNP behavior under mechanical and environmental stress.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Harrie Ha

Academic Institution: University of Colorado Boulder

Major: Computer Science

**Academic Standing
(Sept. 2026):** Junior

**Future Plans
(School/Career):** Graduate Studies

**NIST Laboratory,
Division, and Group:** NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

**NIST Research
Advisor:** James Fitzgerald, Elizabeth Kelley

Title of Talk: Simulating the Effects of Charged Lipids on Bilayer Area Compressibility

Abstract:

Lipid bilayers form the foundation of the cell membrane, and their mechanical properties influence many important cellular processes such as cell division and cellular respiration. These membrane properties are highly dependent on the chemical structure of the lipids that make up the bilayer. Many naturally occurring cell membranes as well as synthetic membranes designed to study membrane properties or engineered for cell free protein synthesis and drug delivery applications incorporate charged lipids. However, the effects of these charged lipids on bilayer dynamic properties like area compressibility are relatively understudied, and it is somewhat naively assumed that no effect is incurred from their addition. To measure these effects, we will be computing area compressibility using all-atom molecular dynamics simulation in GROMACS with mixtures of neutral lipids (DPPC, the common mixture egg sphingomyelin (ESM), and POPC), and charged lipids (DPPS, DPPG, and POPS).



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Aanya Tiwari

Academic Institution: University of Maryland - Baltimore County

Major: Bioinformatics & Computational Bio

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Graduate Studies

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

NIST Research Advisor: Dr. Shayna Hilburg and Dr. Yun Liu

Title of Talk: Techniques to visualize and quantify monoclonal antibody flexibility from simulations

Abstract:

Monoclonal antibodies (mAbs) are an important class of modern medicines, but because they are large and highly flexible, tracking their molecular motion is a major challenge. In order to address this, we are studying a benchmark antibody named NIST Monoclonal Antibody Reference Material (NISTmAb RM 8671). NISTmAb's molecular motions can be experimentally measured using a correlation function called the Intermediate Scattering Function (ISF), which can be calculated from the results of Neutron Spin Echo (NSE) at the NCNR. A challenge of this approach is that the ISF is mathematically highly complex and difficult to translate directly into physical shapes and 3D movement. This project uses a dimensionality reduction technique known as Principal Component Analysis (PCA) and applies it to all-atom Molecular Dynamic (MD) simulations of NISTmAb in order to make these movements easier to quantify. Working on the NIST high performance computing clusters, we apply PCA to large all atom simulation trajectories of NISTmAb in order to determine main dynamic modes from the simulations. By projecting the data onto these top principal components, the complexity is reduced which allows us to easily compare the movements between replicate simulations. We also create molecular visualizations, showing exactly which way the antibody domains move along these components. Ultimately, the results will further the integration of MD simulations with Neutron Spin Echo (NSE) for improved interpretation of protein dynamics and characterization of flexible biomacromolecules.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Priscilla Ye

Academic Institution: Cornell University

Major: Chemical Engineering

Academic Standing (Sept. 2025): Junior

Future Plans (School/Career): Pursuing a PhD in Chemical or Materials Science Engineering

NIST Laboratory, Division, and Group: MML / Chemical Sciences Division / Chemical Process and Nuclear Measurements Group

NIST Research Advisor: Dr. Jamie Weaver

Title of Talk: From Bulk Sampling to Microscopic Characterization of Lithium-Ion Battery Black Mass

Abstract:

Within the last several years, tens of millions of electric vehicles (EVs) were registered globally. In less than a decade, the lithium-ion batteries (LIBs) from these EVs will reach the end of their lifespans (Global EV Outlook 2024). This necessitates a robust LIB recycling infrastructure to facilitate a circular economy that accounts for materials from battery fabrication through end-of-life to the recycling of valuable precious metals found in the cells, where the cycle can begin again. However, the process is complicated by the fact that LIB cathode chemistries are more diverse than those of other battery types, making a one-size-fits-all approach difficult to implement (Rehman et al.).

My project is informed by an industrial need to develop robust protocols for black mass, which, according to the International Organization for Standardization, refers to “dark-colored powder or shredded material made of lithium and other battery components, obtained from manufacturing scrap and end-of-life batteries” (ISO 7819:2025 3.6.2). These protocols include downsizing, characterization, and microscopic image analysis of black mass. I developed procedures to cryogenically mill simulate black mass consisting of polymers and graphite to obtain a desired range of particle sizes for further spectroscopic characterization. To validate particle size and evaluate sample composition, I developed methods for microscopic imaging, image processing, and particle analysis. A secondary goal of my research was to identify key black mass characterization techniques through a scoping review of patents on LIB recycling technology to identify currently used methods. This will further inform the development of a standardized process for characterizing LIB black mass.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Lydia Bullock

Academic Institution: Hamilton College

Major: Physics and Mathematics

Academic Standing (Sept. 2026): Graduated class of 2026; incoming graduate student

Future Plans (School/Career): Master's degree at the University of Wisconsin-Madison in Quantum Computing

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610, Research Facility Operations Group (Group 3)

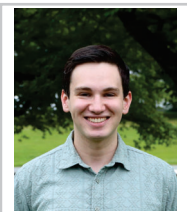
NIST Research Advisor: Wangchun Chen and Shannon Watson

Title of Talk: Building the Next Generation of NMR Software for Polarized Neutron Scattering Instruments

Abstract:

Polarized neutron scattering is a technique widely used in hard and soft condensed matter systems to distinguish the magnetic structure, atomic structure and elementary excitations and dynamics of materials. At the NIST Center for Neutron Research (NCNR), researchers from across the nation and around the world utilize our neutron source for polarized neutron scattering experiments. These experiments require a polarized neutron beam, which is produced and analyzed using neutron polarizing devices such as the ^3He neutron spin filter (NSF). As neutrons pass through the filter, the ^3He nuclei absorbs neutrons with spins anti-parallel to the ^3He nuclear spin while transmitting those with parallel spins, resulting in net polarization of the neutron beam. After scattering from the sample, analysis of the polarization state of scattered neutrons is also achieved by the same principle.

At the NCNR, polarized neutron capabilities using ^3He spin filters have been established on several instruments, which rely on the precise characterization and control of the ^3He nuclear spin polarization via Nuclear Magnetic Resonance (NMR) techniques. These NMR procedures are currently controlled by legacy software developed nearly twenty years ago in the IGOR Pro programming language. The first part of this project aims to update the existing software and improve the program's reliability by removing deprecated functions, correcting syntax, and ensuring proper hardware communication. In the second part of this project, we try to develop the necessary NMR methods in the modern python programming language as a replacement for the existing IGOR Pro implementation. Reproducing these NMR methods in Python will improve interoperability with instrument control systems, facilitate integration with modern hardware, and ensure successful operation of advanced polarized neutron scattering processes at the NCNR.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Henry Pires-Tolson

Academic Institution: University of Maryland

Major: Physics & Computer Science

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Graduate studies in Physics

**NIST Laboratory,
Division, and Group:** NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

**NIST Research
Advisor:** Nicholas Butch

Title of Talk: Analyzing magnetic properties of chemically-tuned nickel compounds

Abstract:

I am studying a series of nickel compounds that contain scandium and yttrium. The goal of the study is to determine how controllably varying the chemical composition affects the magnetic properties of the compounds. I have synthesized polycrystals and found that our magnetometry data does not match the literature, implying that some interesting magnetism may have been previously missed. To investigate more precisely, we are making single crystals and will perform powder neutron diffraction studies. The single crystals will be made with a Bridgman furnace or tetra-arc furnace. I will be talking about making the single crystals, analyzing the magnetometry data of the polycrystals, and the reasoning for using neutron diffraction in the near future.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Carina Jacobson

Academic Institution: Purdue University

Major: Physics, Mathematics

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Pursue a Ph.D. in Materials Science or Applied Physics

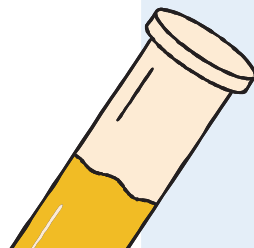
**NIST Laboratory,
Division, and Group:** NIST Center for Neutron Research, Div. 610, Neutron-Condensed Matter Science Group (Group 2)

**NIST Research
Advisor:** William Ratcliff

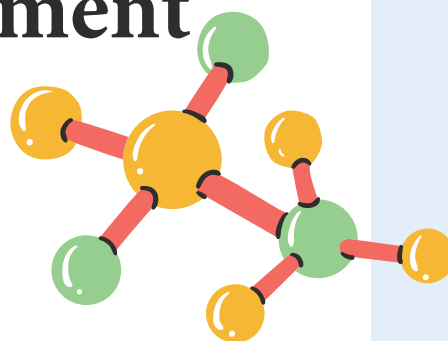
Title of Talk: A scientific wingman: AI co-pilot for triple-axis spectrometer users at the NCNR

Abstract:

The NIST Center for Neutron Research (NCNR) is a national user facility that invites a wide variety of visiting researchers to conduct neutron measurements. An instrument available to users is the triple-axis spectrometer (TAS), a thermal neutron scattering instrument with the ability to select incoming neutron energy, scattering angle, and outgoing neutron energy. The three axes are ideal for inelastic neutron scattering measurements to probe the atomic and magnetic dynamics of a material. To increase user efficiency on this instrument, we introduce TAS Co-pilot, an AI-assisted architecture for triple-axis experiment planning and analysis. TAS Co-pilot integrates evidence spanning papers, instrument scans, metadata, analysis tools, and human knowledge into an AI chatbot, enabling users to ask questions to guide their experimental proceedings. With the ability to readily investigate measurements made on similar materials, suitable starting parameters for scans, and overnight scan summaries, triple-axis studies are increasingly user friendly. In this talk, I present a case study for thermal neutron scattering measurements on strontium manganese antimonide (SrMn_2Sb_2) to demonstrate the workflow of TAS Co-pilot for future experimenters at the NCNR. I show TAS Co-pilot as a tool to find suggested peaks for crystal alignment and to conduct spin wave and resolution calculations.



Physical Measurement Laboratory 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Physical Measurement Laboratory (PML) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Miles Antaya (*plenary speaker*) - Bond Strength Measurements of Semiconductor Wafers

Myriam Bajani - Cryogenic LC Resonators for RF Reflectometry and Sub-pF Capacitance Measurements

Tenaya Chen Lin - Developing an Interferometric Method for Dose Distribution Measurement in FLASH Radiotherapy Using Inverse Abel Reconstruction

Blayne Fuller (CHIPS) - Automated and Scalable Fast Id-Vg Measurements for SiC Transistor Reliability Characterization

Eugene Im - Position Correlation of Biphotons Using Gated Single Photon Imaging Method

Lavanya Mahajan (CHIPS) - Defect Characterization of SiC MOSFETs Using Electrical Measurements and EDMR

Juandiego Astudillo - Progress Developing Frequency-Multiplexed Data Acquisition for Charged Particle Thermal Kinetic Inductance Detector

Matthew Bertagna - Pulse Processing of Initial Charged Particle Data from Prototype Thermal Kinetic

Thomas Gallagher - Characterization of a Scintillation-Based Neutron Detector

Asher Greenberg - Modernizing an Automated Ionization Chamber for Secondary Radioactivity Standards

Kai Tucker - Novel Monte Carlo Simulation of High-Purity Germanium Detector for Characterization of NIST Standard X-ray Beams

Thea Bielejec - Reestablishing a Cold Atom Experiment for Bose-Einstein Condensate Production

Gretchen Ferguson - Algorithmic Optimization of Star-Mesh Quantized Hall Resistance Networks

Esther Kwon - Characterizing the Saturated Optical Response of Rubidium Vapor

Tama Padwa - Transfer Length Method for Metal–Graphene Contact Resistance Measurement

Julian Vye - Characterization of an epitaxial graphene QHE device

Jackson "Jake" Bender - Orientation-Dependent Errors in Contrast Targets Used with Terrestrial Laser Scanners

Graham Dohne - Developing a Reference Length Uncertainty Budget for Terrestrial Laser Scanner Interim Testing

Kaushik Elavarasu - Determining “small” volumes accurately for primary standards

Clark Misener - Temporal and Spatial Correlations in Vicarious Calibration Measurements: Implications for Satellite Sensor Uncertainty

Sylvia Yu - In-situ mass measurement and comparison of optomechanical pressure sensors

Chase Gomes - Towards a Portable Compact Blackbody-radiation Atomic Sensor (CoBRAS)

Gabriel Hernandez - Automated Chip-Scale Characterization of Standard Photonic Thermometers (SPoTs)

Ramon Perez - Doppler Broadening Thermometry

Johnari Price - Laser Noise Characterization for Doppler Thermometry

Cameron Tchir - Multi-fidelity Surrogate Modeling for Optical Critical Dimension Metrology

Ian Alves - Density Determination of Small Mass Standards for Surface Layer Correction

Josiah Main (CHIPS) - Automating in operando Optical Spectroscopy to Probe the Proximity Effect in 2D Materials

Abhishek Roy - Partial Measurement Driven Emergence of Quasiparticles in 1D Lattices

Finn Waltrip (CHIPS) - A Classroom Kibble Balance: Calibration-Free Mass Measurement

Yoon Thwel - Developing Interactive Measurement Educational Resources

Dominick Mendez - Tracking the Stability of Inter-laboratory Comparison (ILC) Equipment Over Time

Matthew Adler - Toward Efficient Coupling Between Photonic Integrated Circuits and Light Sources

Mark Amery - Development of a Phase Locked Stroboscopic Imaging System for Optomechanical Membranes

Jesus Romero - Integrated Sensors for Barrier Tissue Models in Organ on a Chip Systems

Jeremiah Wiener - Hyperspectral Imaging of Semiconductor Quantum Dots



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Myriam Bajani

Academic Institution: Virginia Tech

Major: Computer Engineering

Academic Standing (Sept. 2026): Senior

Future Plans (School/Career): Graduate School and the Semiconductor Industry

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Nanoscale Device Characterization Division, Atom Scale Device Group

NIST Research Advisor: Joshua M. Pomeroy

Title of Talk: Cryogenic LC Resonators for RF Reflectometry and Sub-pF Capacitance Measurements

Abstract:

Throughout this summer, I have been designing and testing resonant circuits for RF reflectometry to detect extremely small electrical changes.

I designed, simulated, and built multiple series and parallel LC resonators to compare different circuit configurations. For each resonator, I characterized its RF response using S11 measurements and compared the results with LTspice simulations. I then adjusted the LTspice schematic until the simulated response matched the measured response, allowing me to estimate the parasitic components of the physical circuit.

By repeating these measurements at room and cryogenic temperatures, I investigated how impedance matching, parasitics, and circuit configuration affect quality factor (Q) and resonant frequency. Under cryogenic conditions, several optimized designs achieved Q values of about 500, well above the Q values typically observed in PCB-based LC resonators, which are often on the order of 10-100. These high-Q resonators provide the sensitivity needed to measure sub-picofarad capacitances through resonance frequency shifts.

Building on this work, the project now shifts toward RF reflectometry using an optimized series LC resonator. The next step is to integrate the resonator with the OPX control system to perform RF reflectometry measurements and, if time permits, extend the setup to measure a device.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Tenaya Chen Lin

Academic Institution: Wellesley College

Major: Physics

Academic Standing
(Sept. 2026): Junior

Future Plans
(School/Career): Graduate School

NIST Laboratory,
Division, and Group: Physical Measurement Laboratory, Radiation Physics Division, Dosimetry Group

NIST Research
Advisor: Dr. Ronald Tosh

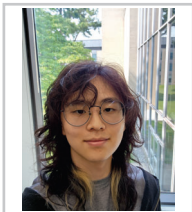
Title of Talk: Developing an Interferometric Method for Dose Distribution Measurement in FLASH Radiotherapy Using Inverse Abel Reconstruction

Abstract:

Ultra-High Dose-Rate (UHDR) FLASH radiotherapy has emerged as an effective cancer treatment for killing cancerous cells while sparing surrounding healthy tissue. However, methods for accurately measuring and imaging the delivered radiation dose distribution without disturbing the radiation field are still being developed. This project aims to use optical metrology to improve the sensitivity and accuracy of radiation dose measurement and two-dimensional dose imaging by measuring radiation-induced temperature changes on the order of a few millikelvin. To ensure precise and reliable measurements, we designed an interferometer that produces high-contrast fringes while minimizing mechanical noise through a common-path design.

We developed a common-path Fabry-Perot etalon inspired interferometer in which a water cell, used to model the human body, is placed between the two reflective surfaces. A laser beam is expanded in order to illuminate a larger measurement region in the water cell before entering the optical resonator, where multiple reflections between the two reflective surfaces create an interference pattern. The water is heated by a radiation beam traveling orthogonally to the expanded laser beam. We are currently investigating approaches for converting interferogram data into a temperature distribution. One approach draws upon Husmann's holographic interferometry method, in which interferograms acquired before and after irradiation are compared to isolate fringe shifts. We also investigate Fourier transform methods, including the Takeda algorithm, to retrieve phase profiles from the interferograms. To reconstruct a two-dimensional radiation dose distribution, we evaluate the use of an even polynomial inverse Abel transform to recover the radial refractive-index distribution from the measured phase shift. The even polynomial fitting method mitigates noise amplification due to numerical differentiation and avoids evaluating the singularity present in the inverse Abel transform. Using a calorimetric approach, we are able to relate changes in refractive index to the corresponding temperature rise following irradiation, which allows us to determine the absorbed dose. We find that our Fabry-Perot etalon inspired interferometer demonstrates greater mechanical stability and higher fringe contrast than the Mach-Zehnder interferometer. The acquired interferometric measurements will be used to develop a phase retrieval and dose reconstruction method.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
	Name: Blayne Fuller	
	Academic Institution: Washington State University	Major: Electrical Engineering
	Academic Standing (Sept. 2026): Junior	
	Future Plans (School/Career): Work as an electrical engineer in the field of defense, pursue an MSEE or PhD	
NIST Laboratory, Division, and Group: PML - Nanoscale Device Characterization Division, Advanced Electronics Group		
NIST Research Advisor: Stephen Moxim, Evgheni Strelcov		
Title of Talk: Automated and Scalable Fast Id-Vg Measurements for SiC Transistor Reliability Characterization		
Abstract: As domestic power consumption continues to increase, demand for high-performance, wide-bandgap, power semiconductor devices such as silicon carbide (SiC) transistors has exploded. Reliability issues such as the negative bias temperature instability (NBTI) prevent the adoption of SiC transistors in high-reliability applications. Advancements in reliability characterization for this technology will support the development of robust and efficient domestic power grids, datacenters, transportation systems, and manufacturing infrastructure. Studying SiC device reliability issues often involves meeting unique metrological challenges. In the case of NBTI, device behavior evolves across many orders of magnitude in time. This requires high-frequency measurement acquisition before and after accelerated stressing conditions that last from microseconds to years. Fast (<100 ns) drain current vs. gate voltage (fast Id-Vg) sweeps have previously been used to observe NBTI degradation, but they present two issues: 1) The hardware often requires manual intervention to initiate the fast IDVG sweep, and 2) Studies on the timescale of months or years are often considered an unrealistic use of wafer probing station resources. This work investigates a methodology for performing fast Id-Vg sweeps with sub-100 ns sweep times during continuous NBTI stressing conditions over at least 12 orders of magnitude in time. We aim to demonstrate compatibility with traditional probe station hardware, as well as a custom PCB approach. In doing so, we seek to bridge the gap between traditional fast Id-Vg measurements and long-term, automated device reliability studies.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Eugene Im

Academic Institution: Johns Hopkins University

Major: Electrical Engineering

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Graduate School/Masters Degree

NIST Laboratory, Division, and Group: PML,

NIST Research Advisor: Martin Sohn

Title of Talk: Position correlation of biphotons using gated single photon imaging method

Abstract:

Since the formulation of the Einstein–Podolsky–Rosen (EPR) paradox, quantum entanglement has become an important aspect of quantum information science, enabling applications in quantum communication, computing, and sensing. Recent advancements of high performance photon counting cameras enable direct imaging of single-photons to characterize position correlation between two entangled photons. This research aims to elucidate photonic quantum entanglement in position by characterizing broadness of linearity in position correlation of biphotons, extending the use of entanglement as a potential resource for quantum-enhanced imaging beyond the limits of classical microscopy via super-resolution imaging, utilizing the position entanglement of biphotons. An experiment to perform the imaging of entangled biphoton is composed of three parts: first, generation of 810 nm biphoton in two orthogonal polarizations via Type II spontaneous parametric down-conversion (SPDC) using a periodically poled Potassium Titanyl Phosphate (PPKTP) crystal pumped with 405 nm laser, second, optics for separating the biphotons using polarizing beamsplitters and imaging onto camera using a lens, and finally imaging single-photon pairs using an intensified scientific complementary metal-oxide-semiconductor (IsCMOS) camera which enables nanosecond gating for coincidence imaging. With their positions compared on a correlation graph using single-photon image processing, correlation analysis is expected to show proof of the position entanglement between the generated photons, further establishing a foundation for future super-resolution microscopic imaging experiments.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Lavanya Mahajan		
Academic Institution: Massachusetts Institute of Technology	Major: Electrical Engineering and Computing	
Academic Standing (Sept. 2026): Rising Sophomore		
Future Plans (School/Career): Pursue a Masters in Engineering (MEng) at MIT		
NIST Laboratory, Division, and Group: NIST Physical Measurement Laboratory, Nanoscale Device Characterization Division, Advanced Electronics Group		
NIST Research Advisor: Dr. Jason Ryan & Dr. Cooper Voigt		
Title of Talk: Defect Characterization of SiC MOSFETs Using Electrical Measurements and EDMR		
Abstract: Silicon carbide (SiC) is emerging as a promising replacement for silicon in power electronics due to its high breakdown voltage, superior thermal conductivity, low ON-state resistance, and ability to operate efficiently at elevated temperatures. Despite these advantages, reliability characterization and metrology for SiC MOS devices remain less mature than those established for conventional silicon technologies. Identifying and understanding defects that degrade device performance and long-term reliability is therefore essential for continued advancement of SiC power electronics. In this study, we characterize transistor aging induced by prolonged gate-oxide electric field stress, using time-dependent dielectric breakdown (TDDB) as the stress protocol. Initial pre-stress electrical measurements are conducted on 150×40 μm channel SiC MOSFETs across multiple dies, including capacitance – voltage (C – V) sweeps, transfer characteristics (I_d – V_g), output characteristics (I_d – V_d), gate leakage (I_g – V_g) measurements, and charge pumping, all acquired using a semiconductor parameter analyzer. Devices are then subjected to TDDB stress at gate oxide fields ranging from 7 to 9 MV/cm for varying durations, after which these measurements are repeated to quantify stress-induced degradation in device performance and interface quality. To further investigate the microscopic origin of the deterioration, electrically detected magnetic resonance (EDMR) measurements were performed following electrical stressing. EDMR probes paramagnetic defects, such as dangling bonds and interface-related charge traps, which can degrade carrier transport and device reliability. By combining conventional electrical characterization with EDMR, this work correlates electrical degradation with underlying defect structure, providing insight into the mechanisms governing gate oxide reliability in SiC MOSFETs.		

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: JD Astudillo		
Academic Institution:	Florida Atlantic University	Major: Electrical Engineering
Academic Standing (Sept. 2026):	Senior	
Future Plans (School/Career):	Industry	
NIST Laboratory, Division, and Group:	PML, radiation physics division, neutron physics group	
NIST Research Advisor:	Thomas Rao	
Title of Talk:	Progress Developing Frequency-Multiplexed Data Acquisition for Charged Particle Thermal Kinetic I	
Abstract:		
NIST is developing a novel cryogenic quantum sensor, called a charged particle thermal kinetic inductance detector (CP-TKID). These sensors are designed to reach low detection thresholds, which will facilitate detection of electrons and protons in the energy ranges relevant for neutron beta decay. We aim to build an array of thousands of CP-TKIDs to surround a neutron beam and measure these decay products. Such an experiment can reach competitive sensitivity for beyond Standard Model physics		
A TKID consists of a superconducting LC resonator circuit patterned on a silicon absorber. Unlike traditional TKIDs, which measure photons, CP-TKIDs are much larger so that they can fully absorb charged particles. Incident energy from a charged particle heats up the TKID, changing the circuit's inductance and thus its resonant frequency. This change in resonator frequency is the signal we collect from each sensor. Because each TKID can be designed with its own resonant frequency, they can be easily multiplexed and are ideal for scaling up to large-area experiments.		
Currently, we are limited to reading out from a single CP-TKID using a synthesizer to generate a probe tone and an oscilloscope to capture data. We report on progress replacing these tabletop devices with the RFSoc 4x2 board, programmed with a modified version of MazinLab Gen3, an open-source hardware overlay, that will reduce noise, improve pulse capture rate, and allow us to read out thousands of CP-TKIDs per RFSoc board.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Matthew Bertagna

Academic Institution: Clemson University

Major: Physics

**Academic Standing
(Sept. 2026):** Sophomore

**Future Plans
(School/Career):** Nuclear Physics

**NIST Laboratory,
Division, and Group:** PML, Radiation Physics, Neutron Physics

**NIST Research
Advisor:** Tom-Erik Haugen

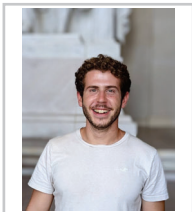
Title of Talk: Pulse Processing of Initial Charged Particle Data from Prototype Thermal Kinetic

Abstract:

Charged Particle Thermal Kinetic Inductance Detectors (CP-TKIDs) are a novel class of superconducting quantum sensors being developed and tested by the Neutron Physics Group and Quantum Calorimeters Group at NIST. We intend to ultimately construct a full-scale neutron beta decay experiment utilizing an array of O(10k) detectors to search for physics beyond the Standard Model. CP-TKIDs are designed to measure energies of individual charged particles with 10x improved energy resolution over existing semiconducting detectors. A CP-TKID consists of a superconducting resonator circuit on a thermally isolated silicon base. When a particle strikes the silicon and deposits energy in the form of heat, the change in temperature shifts the resonant frequency of the circuit, which can be measured with high precision. The output is a millisecond-long decaying thermal pulse. Extracting the energy of the pulse requires accurate determination of the amplitude, which is nontrivial, as it is highly sensitive to pulse shape variations.

The first tests of prototype detectors with charged particle sources were performed this summer. Current prototypes have shown O(10%) FWHM energy resolution, about 100x worse than the predicted optimal performance. We applied and compared several pulse processing techniques to the data, including trapezoidal filtering and optimal filtering. We investigated the pulse shape dependences and developed an analysis pipeline for more accurate pulse amplitude estimation. This work along with ongoing detector design has resulted in an improved pulse height resolution—with the opportunity for additional improvement—and has helped inform data collection and future detector designs.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Thomas Gallagher		
Academic Institution: North Carolina State		Major: Nuclear Engineering
Academic Standing (Sept. 2026): Junior		
Future Plans (School/Career): Graduate school		
NIST Laboratory, Division, and Group: PML, Radiation Physics Division, Neutron Physics Group		
NIST Research Advisor: Daniel Jardin		
Title of Talk: Characterization of a Scintillation-Based Neutron Detector		
Abstract: Traditional neutron detection relies heavily on helium-3 proportional counters, which are limited by the scarcity and high cost of the isotope, high operational voltage requirements, and an inability to operate in strong magnetic fields. These limits create major barriers for deployment in environments like fusion reactors, proton therapy, and space exploration. To solve these issues, NIST, in collaboration with the University of Maryland, is developing the Cellular Array Neutron Spectrometer (CANS). This novel detector uses thin boron-10 films, xenon gas, and silicon photomultipliers (SiPMs) to create a system that runs on a fraction of the voltage, is immune to magnetic interference, and is much more cost-effective in comparison to helium-3. My project this summer focuses on characterizing the newly built prototype to push the detector towards operational readiness. Testing was conducted by exposing the detector to various radiation environments, such as different radioactive isotopes, neutron generators, and the University of Maryland reactor thermal column. Characterizing this prototype required working through several operational hurdles, including electronic noise issues and a potential xenon leak that results in detector degradation within 2 weeks. To better understand the output and optimize hardware capabilities, test data were compared to simulated models made in MCNP, which simulated thermal neutron flux in the detector from the various radiation fields. A custom Python GUI and data analysis software were also developed to process the test data. Ultimately, this work is providing insights for the next iteration of detectors and laying the groundwork to scale this technology into a 2D array capable of producing accurate neutron energy spectra.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Asher Greenberg

Academic Institution: University of Connecticut

Major: Physics

Academic Standing
(Sept. 2026): Junior

Future Plans
(School/Career): R&D, entrepreneurship in emerging energy and infrastructure technologies.

NIST Laboratory,
Division, and Group: PML-Radiation Physics Division

NIST Research
Advisor: Max Carlson

Title of Talk: Modernizing an Automated Ionization Chamber for secondary radioactivity standards

Abstract:

The automated ionization chamber or "AUTOIC" has been in use for almost two decades in the radioactivity group as a secondary standard for activity of radionuclides. The current generated by the ionized gas in the chamber can be measured and then be directly related to the activity of the radionuclides in the sample. Integral to the chamber is a custom-built robotic hand that can exchange up to 100 samples from a programmed task list. Handling these sources automatically is both safer for the user, by reducing radiation exposure, and allows for the measurements to occur without human presence. The latter enables multiple measurements to be made over time which is critical for reducing statistical uncertainty.

The automatic sample exchange robot has been nonfunctional for the past year due to legacy hardware and software interface incompatibility. My project has been focused on fixing these issues which requires implementing modern USB to Serial stepper motor controllers and by building a LabView program to monitor and control the robot. The LabView virtual instrument (VI) architecture follows a standard state machine design. This allows the user to easily jog each axis, set the coordinates for each sample, control the hand and home the robot to its limit switches. Another VI allows researchers to create task lists for the robot. These task lists are then converted into actionable instructions for the robot which can then run autonomously. Both VIs have been prototyped with a non-motorized device, and then loaded on the sample exchange robot computer and confirmed to operate in a fail-safe manner.



SURF Student Colloquium

NIST – Gaithersburg, MD August

3-6, 2026

Name: Kai Tucker

Academic Institution: California Institute of Technology

Major: Applied Physics & Bioengineering

Academic Standing Sophomore
(Sept. 2026):

Future Plans Graduate School in Physics
(School/Career):

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Radiation Physics Division, Dosimetry Group

NIST Research Advisor: Csilla Szabo-Foster

Title of Talk: Novel Monte Carlo Simulation of High-Purity Germanium Detector for Characterization of NIST Standard X-ray Beams

Abstract:

Accurate X-ray spectral characterization is essential for establishing reliable dosimetry standards used in medical imaging and radiation protection. High-purity Germanium (HPGe) detectors provide the highest resolution among energy-dispersive solid-state semiconductor detectors with sub-keV energy resolutions, high detection efficiencies, making them reliable tools in X-ray spectrometry.

The NIST Dosimetry Group is commissioning an Ultra-Low Energy HPGe detector to directly measure spectra of standard X-ray beams from 10 keV to 300 keV. In the course of this work, we established an energy calibration using the gamma-ray sources Co-57, Cd-109, Am-241, and Ba-133 with varying filtration. To verify the fidelity of the detector's measured spectra, we present a detailed model of the experimental system in TOPAS, a Geant4-based Monte Carlo particle transport platform, enabling direct comparison between measured and simulated spectra. Utilizing the python toolkit SpekPy, we generated the spectra of standard NIST beam qualities and incorporated them as source spectra within the simulation. Following established Monte Carlo efficiency benchmarking methodology for gamma-ray spectrometry, we validated the model prior to comparison with measured X-ray spectra, ensuring accurate implementation of the physics processes and sensitive volume scoring.

This work constitutes the first Monte Carlo model of this detector system, providing confidence in future high-accuracy characterization of NIST standard X-ray beams and supporting the next generation of national X-ray dosimetry standards.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Thea Bielejec

Academic Institution: Purdue University

Major: Physics

Academic Standing
(Sept. 2026): Senior

Future Plans
(School/Career): Graduate School

NIST Laboratory,
Division, and Group: Physical Measurement Laboratory, Quantum Measurement Division, Laser Cooling and Trapping Group

NIST Research
Advisor: Ian Spielman

Title of Talk: Reestablishing a Cold Atom Experiment for Bose-Einstein Condensate Production

Abstract:

Bose-Einstein condensates (BECs) provide a highly controllable platform for quantum simulation, that can reproduce the behavior of complex many body systems that are difficult to study directly. Studying these model systems can extend our understanding of the quantum behavior of materials relevant to future technologies. Producing a BEC requires laser cooling and trapping of atoms using magnetic and optical fields, followed by evaporative cooling to ultracold temperatures (μK).

This project focused on restoring and optimizing a rubidium cold atom apparatus for BEC production while updating the experiment in preparation for the future addition of an optical cavity and to transition away from the previous atom chip to an optical dipole trap. As part of this effort, an automated optimization system based on the machine learning package M-LOOP was reestablished after becoming incompatible with the laboratory's updated control software. New analysis routines were developed to process absorption images, in which atoms absorb discrete wavelengths of light, extracting atom number and cloud size to calculate a temperature proxy from time of flight (TOF) measurements. These measurements are combined into an objective function that allows M-LOOP to automatically adjust experimental parameters between successive experimental runs, maximizing the number of trapped atoms while maintaining the low temperatures required for Bose-Einstein condensate production.

The optimization framework developed during this project provides the tools needed to efficiently optimize the experimental sequence and supports ongoing efforts toward Bose-Einstein condensate production. This automated optimization framework will accelerate optimization of the experimental sequence and provide a foundation for future quantum simulation experiments using ultracold atomic gases.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Gretchen Ferguson

Academic Institution: Auburn University

Major: Physics, Math

**Academic Standing
(Sept. 2026):** Sophomore

**Future Plans
(School/Career):** PhD in Physics

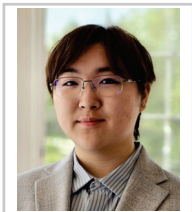
**NIST Laboratory,
Division, and Group:** PML, Quantum Measurement Division, Fundamental Electrical Measurements (684.05)

**NIST Research
Advisor:** Albert Rigosi

Title of Talk: Algorithmic Optimization of Star-Mesh Quantized Hall Resistance Networks

Abstract:

Contemporary star-mesh networks used in high-value quantized Hall array resistance standards designs struggle with physical and infrastructure compatibility limitations. While the current, symmetric configurations successfully minimize the total element count, they experience quantum Hall breakdown under practical test voltages and exhibit poor compatibility with dual-source measurement bridges. The solution presented in this work is an algorithmically optimized asymmetric star-mesh topology which aims to enhance bridge sensitivity and promote connectivity while maintaining a relatively minimal element count by expanding the first and last network branches. Weighted Laplacian matrices were constructed and determined to rule out secondary internal current bottlenecks, and simulations using LTspice were run for values $1\text{ G}\Omega$ and $10\text{ G}\Omega$ to evaluate the resistance outputs, which were within $500\text{ }\mu\Omega/\Omega$ of nominal, offering promise in the pursuit to reduce the traceability chain for global calibrations.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Esther Kwon

Academic Institution: University of Maryland, College Park

Major: Physics, Astronomy

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Graduate School/ PhD in Astrophysics

**NIST Laboratory,
Division, and Group:** Physical Measurement Laboratory, Quantum Measurement Division, Quantum Optics Group

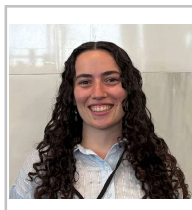
**NIST Research
Advisor:** Zachary Levine

Title of Talk: Characterizing the Saturated Optical Response of Rubidium Vapor

Abstract:

Rubidium vapor cells have been used to create solitons and entangled photon pairs through the process of four-wave mixing. As a dielectric medium, rubidium has strong non-linear properties which change with the intensity of incoming light. These can be described by the Kerr effect, often written as $n = n_0 + n_2 I$, where n_0 is the linear index of refraction, I is the intensity of the light, and n_2 is the Kerr coefficient. Under stronger electric fields, n_2 is more generally described by the saturated Kerr effect: $n = n_0 + n_2(I)I$, where the now-saturated Kerr coefficient $n_2(I)$ depends on the intensity of the incident light.

Despite the fact that rubidium is very easily saturable, theoretical treatments of the Kerr effect have not fully accounted for the saturated nonlinear coefficient. By modeling an electromagnetic wave and its interaction with a multilevel system, we will adapt the Z-scan method to include the effects of saturation. Our model uses a semiclassical approximation that includes the quantum mechanical response of the material and the classical electric field. Our theory supports an on-going experiment at the University of Maryland to characterize laser light through a rubidium vapor cell.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Tamar Padwa

Academic Institution: Georgetown University

Major: Physics

**Academic Standing
(Sept. 2026):** Junior

**Future Plans
(School/Career):** Graduate School in Physics

**NIST Laboratory,
Division, and Group:** PML, Quantum Measurement Division, Fundamental Electrical Measurements Group

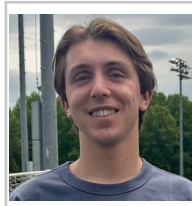
**NIST Research
Advisor:** Yanfei Yang

Title of Talk: Transfer Length Method for Metal–Graphene Contact Resistance Measurement

Abstract:

Graphene, a 2-D hexagonal lattice of carbon atoms, possesses unique electrical properties that make it ideal for intrinsic resistance standards. A single graphene Hall bar offers only one accessible quantum resistance value, which limits its use in calibration. NIST is developing quantum Hall arrays (QHA) based on epitaxial graphene to provide a large range of quantized resistance values, from 100 ohm to 1 gigaohm, which will shorten the calibration chain for traceability. To achieve precise resistance quantization for QHA, it is necessary to minimize the contact resistance as well as the interconnection resistance between Hall bars. While superconducting NbTiN has been integrated in QHA to eliminate the interconnection resistance, the contact resistance cannot be directly measured for each Hall bar in an array. This work applies the transfer length method (TLM) to investigate the factors influencing contact resistance, including contact geometry, graphene morphology, and contact metal. TLM devices with different contact geometries and metals are fabricated to analyze the contribution of top surface contacts and edge contacts to the total contact resistance. The devices are fabricated on epitaxial graphene with different numbers of voids and multilayer patches to probe the effect of graphene morphology on the graphene-metal bond. This research is an important step in improving the contact interface between graphene and metal for further metrology applications.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Julian Vye		
Academic Institution: New Mexico Institute of Mining & Technology		Major: Materials Engineering
Academic Standing (Sept. 2026): Senior (4th year)		
Future Plans (School/Career): Complete Bachelor's in Materials engineering. Pursue a graduate degree in optics.		
NIST Laboratory, Division, and Group:		
NIST Research Advisor:		Alireza R. Panna
Title of Talk: Characterization of an epitaxial graphene QHE device		
Abstract: Modern metrology for electrical SI units relies on quantum effects to realize physical standards. The quantum Hall effect (QHE) in a two-dimensional electron gas (2DEG) system provides the basis for realizing the ohm, the SI unit of electrical resistance, from the revised SI definitions of the Planck constant (h) and elementary charge (e) in terms of $h/(e^2)$. This project details the characterization of an epitaxial graphene Hall bar for use as a quantum Hall resistance standard (QHRS). A liquid helium (LHe) cryostat with a 9 T superconducting magnet was used to perform longitudinal measurements at temperatures < 2 K. Under an applied source-drain current, a zero-voltage difference across contacts on the same side of the device, in the direction of current flow, provides a robust verification of the QHE. We also measured critical parameters of current and magnetic field under which the device remains quantized and show a complete set of transport measurements necessary to characterize a quantum Hall device.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Jackson (Jake) Bender

Academic Institution: Washington University in St. Louis

Major: Physics

Academic Standing Junior
(Sept. 2026):

Future Plans Graduate School or Optical Engineering
(School/Career):

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Sensor Science Division (Div 685.10), Dimensional Metrology

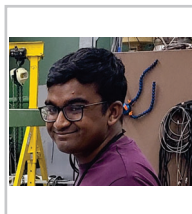
NIST Research Advisor: Bala Muralikrishnan

Title of Talk: Orientation-Dependent Errors In Contrast Targets Used With Terrestrial Laser Scanners

Abstract:

Terrestrial Laser Scanners (TLS) are a form of portable, ground based, LIDAR (light detection and ranging) used to obtain a 3D point cloud of objects or spaces to map their dimensions. TLSs can utilize targets within a space to compare data from different locations or machines to ensure a correct rendition of a scene. Contrast targets are examples of a TLS target and consist of a black and white pattern, usually either an intersection of squares or triangles. Targets can be commercially purchased in metal or plastic forms as well as printed on paper via a laser printer. Unlike a sphere which is three-dimensional, contrast targets are two dimensional. It has been seen that TLS scan suffer from errors finding the center of the contrast target depending on the orientation of the target with respect to the TLS due to the planar nature of the target itself. Specifically, when it comes to the angle of incidence of the plane with respect to the TLS, there seems to be a drift of the contrast target center as the angle increases, a behavior we have observed in multiple TLS models. The focus of this work is on trying to understand and model this apparent drift in the target center as a function of angle of incidence. Likely causes of this phenomena include penetration of the laser within the target material, material of the target, and optical properties of the surfaces. Using a variety of contrast targets covering a broad range of materials and optical properties, we are attempting to identify the reason for this common error within TLSs. This work is being performed in support of an ongoing documentary standards activity within the Organization for Scientific Area Committees for Forensic Science (OSAC) to characterize TLS errors so that law enforcement officers can successfully and easily utilize TLS's in their investigations.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
	Name: Graham Dohne	
Academic Institution: UMBC		Major: Physics
Academic Standing (Sept. 2026):		Sophomore
Future Plans (School/Career):		Career
NIST Laboratory, Division, and Group:		PML, 685, Dimensional Metrology Group
NIST Research Advisor:		Meghan Shilling
Title of Talk:		Developing a Reference Length Uncertainty Budget for Terrestrial Laser Scanner Interim Testing
Abstract:		
Terrestrial laser scanners (TLSs) are used by law enforcement agencies to capture a 3D representation of crime and accident scenes. These instruments are used in the field and may be subject to harsh conditions in the field and during transport, potentially causing errors in the alignment of the optical components, which would propagate as errors in the measurements made. NIST has been involved with OSAC (The Organization of Scientific Area Committees for Forensic Science) to create a standard for interim performance assessment to allow law enforcement agencies to monitor the performance of their TLSs between manufacturer's calibration.		
The interim test requires the users of TLSs to calibrate multiple distances between pairs static targets using a calibrated tape measure. The uncertainty of these reference lengths is important because is related to the magnitude of errors in the TLS that can be detected. For example, if the reference length has an uncertainty of 2 mm, a TLS error of 0.5 mm would not be detected. The aim of this project is to create a generic uncertainty budget for the reference lengths (measured by tape measure) that can be used by law enforcement agencies to determine the level of errors that would be detectible in their TLSs using the interim performance assessment.		
The uncertainty budget need to include the (uncorrected) errors in the tapes and any uncertainty introduced by the reference length measurement process. To do this, I first calibrated fourteen separate tape measures in the NIST measuring tape calibration facility (the tape tunnel), which uses a reference interferometer. All of the tapes were different in certain features such as the width of the tape, the smallest division on the tape, whether or not the tape had metric or imperial markings, and the total length of the tape. For any tape that had both metric and imperial markings, I calibrated both.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Kaushik Elavarasu

Academic Institution: University of Virginia

Major: Mechanical Engineering

Academic Standing (Sept. 2026): Student

Future Plans (School/Career): Aerospace Engineer

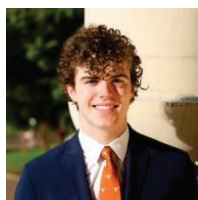
NIST Laboratory, Division, and Group: PML, 685, 2 (The Fluid Metrology Group)

NIST Research Advisor: Jodie Pope

Title of Talk: Determining “small” volumes accurately for primary standards

Abstract:

Low-uncertainty volumetric gas flow standards rely on accurately calibrated reference volumes. These volumes are characterized gravimetrically with water and used with gas expansion techniques to calibrate collection tanks that cannot be filled directly. Demand for lower semiconductor gas flow rates has created the need for highly accurate reference volumes smaller than 200 mL. As reference volumes size decrease, air bubble entrapment during water filling becomes a dominant source of uncertainty, making valve geometry and internal surface finish critical design considerations. The Fluid Metrology Group (FMG) designed 3 small volumes as reference candidates, each with smooth internal finishes and weir valves to minimize entrapped air bubbles. The internal surface of the first volume used in this work was sanded and polished with a scouring pad. Determining its internal volume requires measuring the difference in mass of the empty vessel and the vessel filled with water; however, we found the first reference volume valves’ leaked so we could not evacuate it and determine its empty mass. Given that largest uncertainty in FMG’s past efforts was attributed to air trapped in the reference volume during the filling process, we assessed the reproducibility of the vessel’s mass with repeated fillings of water. We found the standard deviation of 5 repeated mass measurements was 0.19 mg, which is a substantial fraction of the estimated mass of water which is 150 mg. Given this result, we will assess the other candidate volumes to determine if the reproducibility is sufficient to characterize the internal volume of NIST’s new Semiconductor Low Flow Standard’s collection tank.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Clark Misener

Academic Institution: University of Texas at Austin

Major: Environmental Science

Academic Standing Junior
(Sept. 2026):

Future Plans Law or graduate school for geology or environmental sciences
(School/Career):

NIST Laboratory, PML, 685, Remote Sensing Group
Division, and Group:

NIST Research Steven Brown
Advisor:

Title of Talk: Temporal and Spatial Correlations in Vicarious Calibration Measurements: Implications for Satellite Sensor Uncertainty

Abstract:

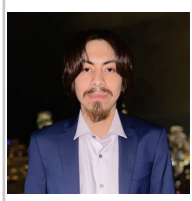
Sensors on satellites are used to make regional and global measurements of optical properties of land, water, and atmosphere, providing information about the state of the Earth's biosphere. Sensor responsivities can change due to vibrations during launch and the harsh environment of space once in orbit, or simply by degrading over time. Monitoring changes in a sensor's response and validating its performance over its mission lifetime is required to properly understand uncertainties in measurements by the space-borne sensor and uncertainties in data products derived from those measurements. Vicarious calibration of satellite sensors is a technique that makes use of radiometrically stable ground targets such as dry lakebeds, desert sites, and open grasslands for the post-launch calibration of these sensors. Top-of-the-atmosphere radiances or reflectances are provided from those sites for the calibration of a sensor. The reflectance of a remote sensing vicarious calibration site is measured by ratioing the signal from a ground target to the signal from a reference target, often a white panel made of PTFE whose reflectance is known. When physically mapping a vicarious calibration site prior to a satellite sensor overflight, there can be elapsed times between the two measurements as great as 10 min and spatial separations as large as 80 m. The solar illumination can vary on time and spatial scales relevant to the time and space between measurements of a ground target and a reference panel.

In this work, I explored the impact of temporal and spatial correlations between two measurements taken outdoors on the Type A uncertainties in their ratios. Greater than a factor of 10 reduction in the coefficient of variation of the ratio taken simultaneously versus sequentially with delays on the order of 5 min to 10 min was realized. Measurements with spatial separations greater than ~ 1 m were uncorrelated. Understanding how much two different sensors fed the same information agree with one another in their results is critical, as that range of variance can be applied to when the two sensors are measuring different entities.

Finally, I'll discuss implications for protocols employed to measure the surface reflectance at sites used for the vicarious calibration of satellite sensors.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Sylvia Yu		
Academic Institution: University of Pennsylvania		Major: Physics
Academic Standing (Sept. 2026): Sophomore		
Future Plans (School/Career):		
NIST Laboratory, Division, and Group:		PML Division 685 Group 9
NIST Research Advisor:		Daniel Barker
Title of Talk:		In-situ mass measurement and comparison of optomechanical pressure sensors
Abstract: We demonstrate progress towards an in-situ calibration method for optomechanical pressure sensors by determining the oscillator's mass from its thermomechanical noise. Optomechanical pressure sensors use gas-induced damping of oscillators to determine vacuum pressure, offering robust sensing but face long-term stability challenges due to drift in the oscillator’s mass. Our approach involves upgrading the apparatus to minimize external noise and implementing new data analysis routines to compensate for frequency drifts. We conducted an indirect comparison of the pressure sensitivity across 7 orders of magnitude between different sensors and mass calibration methods. Our self-calibration will enable long-term deployment in industrial settings by addressing drift caused by surface deposition of condensing gases.		

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Chase Gomes		
Academic Institution: University of Connecticut		Major: Physics
Academic Standing (Sept. 2026): Senior		
Future Plans (School/Career): PhD in Physics		
NIST Laboratory, Division, and Group: PML, Sensor Sciences Division, Fundamental Thermodynamics Group		
NIST Research Advisor: Sai Paladugu		
Title of Talk: Towards a Portable Compact Blackbody-radiation Atomic Sensor (CoBRAS)		
Abstract: The compact blackbody-radiation atomic sensor (CoBRAS) is a portable, primary, and self-calibrating thermometer. By monitoring fluorescence intensity ratios from optically excited atoms in a vapor cell, CoBRAS takes advantage of the fundamental properties of atoms to eliminate the need for repeated calibration. We present progress in the construction of a portable laser-stabilization system necessary for measurements. Additionally, we discuss the prospect of using cesium-133 to determine temperature based on Doppler-broadening thermometry.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Gabriel Hernandez

Academic Institution: University of Illinois Chicago

Major: Engineering Physics

Academic Standing (Sept. 2026): First Year Master's Student

Future Plans (School/Career): Attend graduate school this fall to do my master's degree in electrical engineering with a focus on semiconductor manufacturing and potentially a PhD afterwards.

NIST Laboratory, Division, and Group: Physical Measurement Laboratory - Sensor Science Division, Fundamental Thermodynamics Group

NIST Research Advisor: Nikolai Klimov

Title of Talk: Automated Chip-Scale Characterization of Standard Photonic Thermometers (SPoTs)

Abstract:

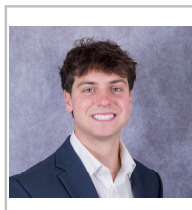
Over the past few years, integrated photonic sensors have advanced rapidly across a growing range of applications, driven by the scalability of integrated photonics and the precision of modern nanofabrication. At NIST's Sensor Science Division, a research team is developing chip scale photonic thermometers as an alternative to Standard Platinum Resistance Thermometers (SPRTs) for disseminating the International Temperature Scale of 1990. A major challenge in advancing these devices is high throughput characterization, which becomes a bottleneck when measuring large arrays of photonic structures on silicon on insulator chips. This project demonstrates a fully automated workflow for characterizing extensive arrays of Standard Photonic Thermometers (SPoTs).

Using custom software to coordinate a six degree of freedom micro positioning hexapod, a digital oscilloscope, and a continuous wave laser, the system reduces full chip characterization time from roughly one week to about one hour. The automation performs coarse and fine alignment routines to maximize fiber to grating coupler coupling and records each optimized position for reproducibility. It then executes a motor driven wavelength sweep from 1510 nm to 1610 nm, identifies resonance features, and returns to each stored location for a high resolution piezo scan. A Fano line shape fit is applied to each resonance to extract the optical quality factor, a key parameter governing optical confinement and ultimately the achievable temperature resolution.

This automated platform enables rapid, repeatable, and scalable evaluation of photonic thermometers, providing a critical tool for advancing SPoT devices toward metrology grade performance.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Ramon Perez		
Academic Institution: Indiana University		Major: Physics
Academic Standing (Sept. 2026): Senior		
Future Plans (School/Career): Grad School		
NIST Laboratory, Division, and Group: PML, Sensor Sciences Division, Fundamental Thermodynamics Group		
NIST Research Advisor: Eric Norrgard		
Title of Talk: Doppler Broadening Thermometry		
Abstract: Doppler Broadening thermometry provides a calibration-free path to primary standards by linking thermodynamic temperature directly to fundamental constants. This work characterizes a deployable thermometer utilizing high sensitivity fluorescence spectroscopy of a cesium-133 vapor cell. We present the experimental apparatus and methodology for analyzing these atomic lineshapes across a range of temperatures.		

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: JohnAri Price		
Academic Institution: Indiana University Bloomington		Major: Physics, Mathematics
Academic Standing (Sept. 2026): Junior		
Future Plans (School/Career): Masters/PhD		
NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Sensor Science Division, Fundamental Thermodynamics Group		
NIST Research Advisor: Benjamin Reschovsky		
Title of Talk: Laser Noise Characterization for Doppler Thermometry		
Abstract: Due to their extreme spectral purity, lasers enable ultra-precise measurements across nearly all areas of physics. However, even state-of-the-art lasers exhibit frequency noise, which must be accounted for in demanding applications. In this project, optical fiber components are used to construct a device to measure fast laser frequency noise. The device consists of a Mach-Zehnder interferometer where the path length of one arm is extended with a length of optical fiber on the order of a few meters. This device was used to measure the Lorentzian linewidth of an external cavity diode laser to less than 450 Hz and of a self-injection locked laser to less than 10 Hz. Accurately characterizing this noise allows these lasers to be deployed in a novel thermometer that NIST is developing based on the Doppler broadening of an atomic gas.		



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Cameron Tchir

Academic Institution: University of California, Santa Barbara

Major: Physics

**Academic Standing
(Sept. 2026):** Junior

**Future Plans
(School/Career):** Pursue physics/engineering research in graduate school or industry

**NIST Laboratory,
Division, and Group:** PML, Sensor Science Division, Surface and Interface Metrology

**NIST Research
Advisor:** Aaron Chew

Title of Talk: Multi-fidelity surrogate modeling for optical critical dimension metrology

Abstract:

Many computer simulations employed in modern science are computationally complex and require immense processing power and time. This issue is exacerbated in inverse problems, where numerous calls to the simulator are required. A popular strategy to address this issue is the multi-fidelity surrogate, a framework that leverages a plentiful low-fidelity dataset to supplement a sparse high-fidelity dataset, yielding a highly accurate and effectively instantaneous model. This surrogate assumes a correlation between the two fidelities.

We construct and employ a multi-fidelity surrogate for scatterometry, a technique used in semiconductor fabrication to measure the critical dimensions of nanostructures. Because the Maxwell solvers used to simulate the electromagnetic response are costly, a high-accuracy surrogate model is needed. The Maxwell solver's complexity scales as $O(N^3)$, with N the number of harmonics used in the plane wave expansion, meaning a high-fidelity dataset is expensive to generate. Thus, a low-fidelity dataset with smaller N is also generated, trading accuracy for data density. The surrogate combines the two datasets with Gaussian processes [1]. We demonstrate that this multi-fidelity approach offers substantial improvements over single-fidelity techniques and apply our model to industrially relevant gratings.

Reference

[1] MC Kennedy, A O'Hagan, Predicting the output from a complex computer code when fast approximations are available, *Biometrika*, Volume 87, Issue 1, March 2000, Pages 1–13, <https://doi.org/10.1093/biomet/87.1.1>



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Ian Alves

Academic Institution: University of Maryland - College Park

Major: Mechanical Engineering

Academic Standing (Sept. 2026): Undergraduate junior pursuing a Bachelor of Science in Mechanical Engineering

Future Plans (School/Career): Seeking out future research opportunities to broaden my knowledge before specializing in a specific field.

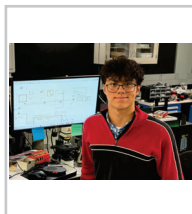
NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Division 684, Group 7: Mass and Force

NIST Research Advisor: Gordan Shaw

Title of Talk: Density determination of small mass standards for surface layer correction

Abstract:

Wire masses are frequently used as small mass standards in high precision metrology. Recent observations have indicated that there is a small difference between the mass measured in vacuum using the NIST electrostatic force balance and that measured in air. This is currently attributed to a surface layer that desorbs under vacuum. To determine an accurate value for a surface mass correction, a series of test masses with varying surface area to volume ratios were made from materials used for small wire masses. Before the surface layer mass correction can be determined, the precise density of the material is needed. To do this a custom instrumentation system mechanism was developed to determine the buoyant force acting on a mass in air and submerged in a liquid. This talk will present the initial results of these density measurements which will ultimately be used to determine the exact surface mass corrections required for these materials.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Josiah Main

Academic Institution: Carnegie Mellon University

Major: Computer Science

Academic Standing (Sept. 2026): Second Year Undergraduate (Class of 2029)

Future Plans (School/Career): Complete Bachelor's in Computer Science

NIST Laboratory, Division, and Group: Physical Measurement Laboratory, 684-05

NIST Research Advisor: Dr. Angela Hight Walker

Title of Talk: Automating in operando Optical Spectroscopy to Probe the Proximity Effect in 2D Materials

Abstract:

This talk presents a LabVIEW-based platform to automate in operando Raman and photoluminescence (PL) spectroscopy experiments as a function of temperature and magnetic field, with simultaneous electrical transport measurements. The experimental set up consists of a triple grating spectrometer coupled to a magneto-cryostat capable of cooling to 1.6 K and applying magnetic fields up to 9 T, along with eight electrical contacts for applying bias voltage. As a testbed for the LabVIEW platform, we measure spectroscopic changes which are signatures of the superconducting proximity effect in a monolayer of MoS₂, a two-dimensional, atomically thin material, in contact with Nb, a superconducting metal. The proximity effect occurs when a superconducting material induces weak superconductivity at the interface surface of a non-superconducting material in contact with it. The effect may cause changes to the quasiparticles (phonons and excitons) in the 2D MoS₂, which can be observed by Raman and PL. As a first demonstration, a routine is presented to measure resistance using the electrical contacts, enabling automation of electrical measurements as a function of temperature or field while collecting optical spectroscopic data simultaneously. Our automated experiments show how the Raman and PL signature of the MoS₂ change as the Nb substrate transitions from non-superconducting to superconducting at low temperature. Second, we address challenges associated with controlling and varying the temperature between spectroscopy measurements. Thermal effects can change the distance from sample to objective enough that laser excitations can be defocused and spectroscopic signals are lost. Focus is achieved by moving the sample towards and away from the objective using a piezoelectric nanopositioner. In automated temperature maps, we introduce an algorithm to maintain focus across different temperatures. At each temperature step, a feedback loop repeats brief spectroscopic measurements and small motions in the direction of increased signal intensity. Development of software to automate different experiments expands the capabilities of the Hight Walker lab, improving the efficiency and quality of data collection.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Abhishek Roy

Academic Institution: San José State University

Major: Computer Science

Academic Standing Junior
(Sept. 2026):

Future Plans Graduate School
(School/Career):

NIST Laboratory, Division, and Group: Physical Measurements Laboratory, Quantum Measurement Division, Laser Cooling Group

NIST Research Advisor: Dr. Ian Spielman

Title of Talk: Partial Measurement Driven Emergence of Quasiparticles in 1D Lattices

Abstract:

Weak or partial measurements of quantum systems, for example, readouts of properties of the system up to a precision cutoff, can combine coherent and incoherent evolution. The quantum Zeno effect can restrict the evolution of the system inside backaction-free subspaces (BFSs), which are configurations that are unaffected by further measurements. Previous research investigated weak measurements of non-interacting fermions on a one-dimensional lattice and found that measurements stochastically drive the system to Fock states. Here we add particle motion between measurements. By including motional effects, we aim to study the entanglement dynamics of the system and potential implications for the system's emergent geometry. Due to the randomness involved in quantum state collapse, numerical computation will be used to plot and gain insight into system behavior. Analytical models will be formed from such insight, allowing us to perform even further numerical calculations to verify our models. We hope to find that the entangling dynamics found in states restricted in a BFS are highly non-local. With such dynamics present, we will search for quasiparticles, possibly moving in emergent geometry. While the results are limited by the number of sites and fermions we use to characterize the 1D lattice, they have considerable implications for the study of emergent geometries in lattices and for the interpretation of naturally occurring phenomena in higher-dimensional lattices.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Finn Waltrip		
Academic Institution: University of Maryland, College Park		Major: Mechanical Engineering
Academic Standing (Sept. 2026): Junior		
Future Plans (School/Career): Graduate School (Mechanical Engineering)		
NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Quantum Measurement Division, Mass and Force Group		
NIST Research Advisor: Dr. Kumar Arumugam and Leon Chao		
Title of Talk: A Classroom Kibble Balance: Calibration-Free Mass Measurement		
Abstract: Since the redefinition of the International System of Units (SI), Kibble balances have been used to realize mass directly from electrical standards without relying on transfer artifacts. These instruments balance the mechanical force of a test mass with an electromagnetic force generated by a voice coil with an applied current (I) immersed in a radial magnetic field of flux density B. The voice coil is characterized by driving the system and measuring the velocity (v) of its motion along with the voltage induced (U) in the coil. With this characterization along with the current applied to the coil during force balancing, we can calculate the value of the test mass. For the purpose of educational outreach, a cost-effective tabletop device has been created with a measurement range of up to 10 g, with a measurement uncertainty goal of less than 1 %. The setup uses an additively manufactured plastic flexure mechanism, a reflective sensor, a pair of magnets, and an in-house-wound coil. Typically, a Kibble balance will use two coils; one to perform the balancing function, and the other to characterize the former. In our novel implementation, a single coil is used to satisfy both of these roles. This initiative was preceded by a similar educational outreach effort, involving a kibble balance constructed using LEGO blocks. This iteration improves on its bulky predecessor by employing a single degree of freedom monolithic flexure mechanism. This vastly simplifies the construction effort and the difficulties in tuning the control parameters. In summary, due to its nature, this prototype is a more cost effective, simpler to construct, and easier to control educational tool.		

SURF Student Colloquium
NIST – Gaithersburg, MD
August 3 to 6, 2026

Name: Yoon Myat Thwel

Academic Institution: University of Maryland, College Park
Major: Technology and Information Design

Academic Standing
(Sept. 2026): Rising Senior

Future Plans
(School/Career): Earn B.A degree in Technology and Information Design from UMD

NIST Laboratory,
Division, and Group: Physical Measurement Laboratory (PML), Office of Weights
and Measures, Metric Program

NIST Research Advisor: Elizabeth Benham

Title of Talk: Developing Interactive Measurement Educational Resources

Abstract:

The NIST Metric Program publishes a variety of K-12 educational materials and curates an extensive website to help classroom educators facilitate student application of International System of Units (SI) skills. Resources include hands-on activities, videos, and guides that enrich classroom curriculum and reinforce student learning. As part of the Office of Weights and Measures (OWM)—which promotes uniformity in U.S. legal metrology laws and ensures measurement accuracy and fairness in commerce—the program plays a vital role in public outreach. While resources exist for a range of grade levels, young learners are often introduced to the metric system only through basic linear measurements. To address this gap, the goal of my project was to design resources that familiarize children with the metric system in a way that aligns with national educational standards while demonstrating its practical, real-world applications.

Through my involvement in enhancing and developing these resources to bridge this gap, I have gained valuable experience in market research, web layout design, and expert consultation. My primary project involved developing a *Metric Measurement Inspector* activity publication for early learners, which introduces students to the role of a food safety inspector while teaching the practical use of degrees Celsius to monitor safe food temperatures. I designed the activity, incorporating national education standards research, iterative design, and initial beta testing with SURF students to create engaging and effective learning experience.

Furthermore, to enhance the overall user experience on OWM's digital platforms, I focused on developing new webpages and upgrading existing web content. In addition to these tasks, I have been involved in other creative projects, such as designing thumbnails for the *Metric Kitchen Recipe* series and developing new resources for NIST Educational STEM Resource Registry (NEST-R). Lastly, to connect our resources with the community, I assisted with an educational outreach event for the Montgomery County Public Schools (MCPS) *Science Leadership Week*, where I worked directly with students and guided them through hands-on metric system measurement activities.

SURF Student Colloquium
NIST – Gaithersburg, MD
August 3 to 6, 2026

Name: Dominick Mendez

Academic Institution: University of Maryland Baltimore County
Major: Chemistry (B.S.)

Academic Standing
(Sept. 2026): Rising Sophomore

Future Plans
(School/Career): Chemistry Professor (PhD or Masters)

NIST Laboratory,
Division, and Group: Physical Measurement Laboratory, Office of Weights and Measures

NIST Research Advisor: Elizabeth Koncki

Title of Talk: Tracking the Stability of Inter-laboratory Comparison (ILC) Equipment Over Time

Abstract:

State legal metrology laboratories are the custodians of state-level measurement standards. SI traceability and standardization of our laboratories in the US not only ensures laboratories are accurate in measurement but minimizes the economic losses to consumers and buyers alike. The impact of weights and measures regulations on the commercial transactions of U.S. products and services amounted to \$12 trillion (45%) of the \$26.4 trillion U.S. Gross Domestic Product (2022). The Office of Weight & Measures (OWM) upholds SI traceability by establishing and running proficiency tests (PTs), that are interlaboratory comparisons, to both support the accreditation and NIST OWM recognition of national laboratories that show proficiency in their items under tests and to provide the participating laboratories with a statistical evaluation of the results and objective performance scores.

These tests rely on PT artifacts owned by OWM as a control value for each participating laboratory in a set PT to measure and then pass to the next lab. However, transport and use between labs can cause these artifacts to become unstable through different chemical and physical means, which requires us to track the stability of these artifacts that are essential to validate and recognize labs throughout the United States.

My stability project is an extension of the Microsoft Excel tools OWM uses to parse data collected from the proficiency test. The goal is to ensure OWM's lab metrology artifacts are stable. By using accumulated PT data as well as verified calibrations from labs and manufacturers, we can chronologically track the stability of proficiency test artifacts. I am developing updated tools to include control charts that display instability analyzing irregular trends in the artifact's reported value. The updated stability template is currently being actively developed, with a beta version able to display the X-bar and R-bar control graph for a 500-pound stainless steel laboratory standard currently in the OWM PT Program. The control graph displays a uniform change in average and range statistics, which metrologists use to determine that the 500-pound artifact has been historically stable up until 2025. This confirms that it is sufficiently stable in the present to serve in another proficiency test. I am continuing this project to expand the updated tools to facilitate analysis of the entire OWM artifact catalog.

Since the raw data is directly officiated by the laboratories participating, this new method of tracking stability will aid metrologists and PT/ILC organizers in and outside NIST to test their artifacts for instability and ensure that the comparisons that lab metrologists see between their labs and others are vetted on a stable control artifact that ensures their proper accreditation or recognition from metrological institutes, including OWM.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Matthew Adler

Academic Institution: University of Illinois Urbana-Champaign

Major: Physics

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Graduate School

**NIST Laboratory,
Division, and Group:** Physical Measurement Laboratory, Microsystems
and Nanotechnology Division, Photonics and
Optomechanics Group

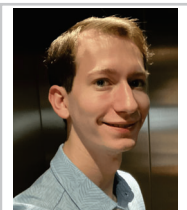
**NIST Research
Advisor:** Jordan Stone

Title of Talk: Toward efficient coupling between photonic integrated circuits and light sources

Abstract: Photonic integrated circuits (PICs) can be used to realize critical optical systems on-chip, with wide-ranging benefits for data centers, quantum sensing, optical atomic clocks, and more. One of the key challenges with realizing fully-fledged chip-scale optical systems is in transferring light from an external source – such as a laser or single-photon source – into nanophotonic waveguides, which are the cornerstone of PICs. This is because the optical modes of fibers and lasers have spatial profiles that differ substantially from single-mode waveguides, reducing the mode overlap that primarily determines coupling efficiency. Without methods of efficiently coupling light between light sources and PICs, there will be significant power losses that inhibit device performance, e.g., by suppressing nonlinear effects or reducing quantum coherence.

To increase coupling efficiency, special waveguide geometries can be made to transfer light between different optical modes. In particular, adiabatic waveguide tapers – in which the waveguide cross-sectional area is slowly varied along the direction of light propagation – effectively funnel light down to small waveguide modes. Additionally, edge couplers are waveguides whose modes are engineered to match the spatial profile of the input light. Combining these structures can dramatically increase the total coupling efficiency.

For this project I built a portable optical imaging system to profile the beams emitted by various lasers. I verified its magnification by comparing the measured mode field diameter of an optical fiber to the manufacturer-specified value. To support that system, I created a simulation infrastructure in Lumerical software to model waveguide tapers and edge couplers, and to calculate the mode overlap between the edge coupler and an elliptical beam measured with the imaging system. From these measurements and simulations, I designed and tested a variety of edge couplers to efficiently transfer light from a laser to a PIC. I will present measurements of the coupling efficiency and discuss potential system improvements.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Mark Amery

Academic Institution: Benedictine College

Major: Physics and Astronomy

**Academic Standing
(Sept. 2026):** Senior

**Future Plans
(School/Career):** Graduate School to pursue a PhD

**NIST Laboratory,
Division, and Group:** Physical Measurement Laboratory, Division 681

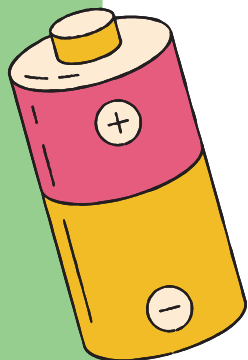
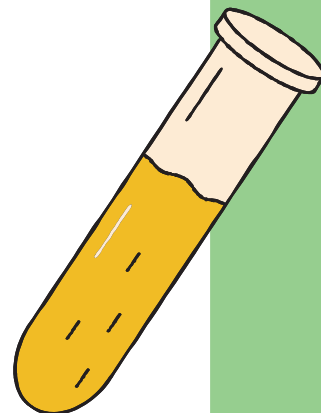
**NIST Research
Advisor:** Dr. John Lawall

Title of Talk: Development of a Phase Locked Stroboscopic Imaging System for Optomechanical Membranes

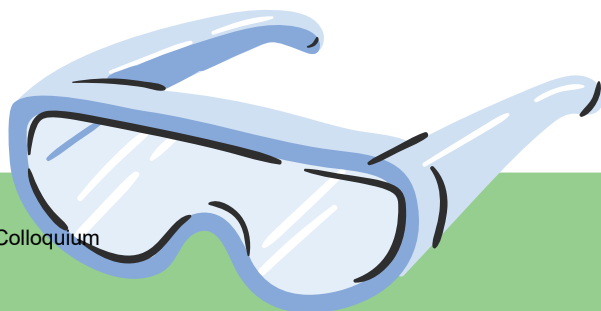
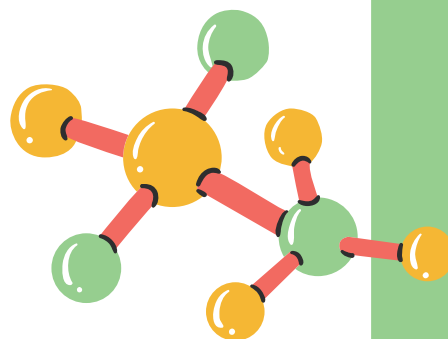
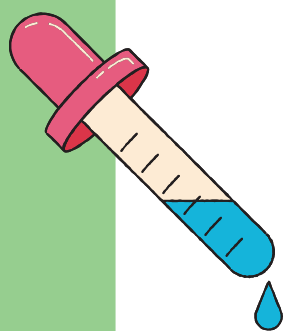
Abstract:

Phononic crystals are periodic nanostructures that confine and control mechanical waves. Direct visualization of their vibrational modes provides valuable insight into their dynamic behavior. However, their mechanical resonances occur on the order of megahertz (MHz), far above the typical 50 Hz frame rate of conventional cameras, making direct imaging impossible. We developed a stroboscopic imaging system for investigating the vibrational modes of phononic crystal membranes. As the typical oscillations are only approximately 1% of the wavelength of visible light, a Michelson interferometer was used to provide the sensitivity required for these measurements. Timing electronics were configured to generate synchronized 50 nanosecond pulses that drove an acousto-optic modulator, producing short optical illumination pulses at controlled phases of membrane motion. The completed system successfully visualized phononic crystal membranes at selected phases, providing a platform for studying high-frequency mechanical behavior that would otherwise be inaccessible with conventional imaging techniques.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Jeremiah Wiener		
Academic Institution: Brown University	Major: Engineering Physics	
Academic Standing (Sept. 2026): Junior, Class of 2028		
Future Plans (School/Career): Pursue graduate education in Engineering or Physics		
NIST Laboratory, Division, and Group: Physical Measurement Laboratory, Microsystems and Nanotechnology Division, 681		
NIST Research Advisor: Dr. Marcelo Davanco		
Title of Talk: Hyperspectral Imaging of Semiconductor Quantum Dots		
Abstract: Solid-state epitaxial quantum dots (QDs) are highly mature single-photon emitters crucial for emerging photonic quantum technologies. However, the inherent ensemble spatial randomness and spectral heterogeneity afforded by QD growth methods poses a challenge for the high yield fabrication of devices which contain a single QD. In particular, isolating QDs with common, narrow emission spectra in an ensemble is critical to achieve multiple sources of indistinguishable single photons for quantum applications. Current photoluminescence (PL) microscopy allows for precise spatial localization of single QDs in ensembles, but lacks rapid, large-scale spectral characterization. Here, we aim to address this gap by developing a tunable optical bandpass filter for wide-field hyperspectral imaging of single QD micro-photoluminescence. By utilizing Python-controlled motorized rotation of tunable optical long-pass and short-pass filters, the system enables bandpass filtering of QD photoluminescence, with a programmable pass-band center wavelength. System accuracy and repeatability were characterized and found to be limited primarily by motor positioning tolerances. Simulations using empirical QD data demonstrated that a single hyperspectral scan can efficiently filter out suboptimal emitters with broad spectra. Once experimentally validated on physical QD arrays, this high-throughput characterization system will drastically accelerate the identification of high-quality single-photon emitters for scalable quantum integrated circuits.		



Communications & Outreach Office (COO) 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants
Communications and Outreach Office (COO) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Shannon Horning - A Data-Driven Analysis of NIST Research Visibility in the Life Sciences



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Shannon Horning

Academic Institution: Carnegie Mellon University

Major: Technical Writing

Academic Standing (Sept. 2026): Graduated

Future Plans (School/Career): Pursue a career in technical writing in the sciences.

NIST Laboratory, Division, and Group: Communications and Outreach Office, 107.04

NIST Research Advisor: Ben Stein

Title of Talk: A Data Driven Analysis of NIST Research Visibility in the Life Sciences

Abstract:

The National Institute of Standards and Technology (NIST) conducts research across a wide range of technical disciplines. Despite this breadth, public awareness of NIST’s work appears to be greatest in areas such as the physical sciences and information technology, while life science research receives comparatively less attention and engagement. To better understand this disparity, NIST news articles, blog posts, social media content, and explainers published between January 2025 and June 2026 were categorized by research discipline and analyzed using engagement metrics. Google Analytics 4 data, including total page views and traffic sources, were collected for each news article, blog post, and explainer. Median and average view counts were compared across disciplines to identify patterns in content performance. Sprout Social metrics were used to evaluate impressions and engagement rates for social media content. Results across platforms confirmed that disciplines outside traditional metrology, such as biomanufacturing and fire research, consistently received below average engagement. Building on these findings, I explore the possible causes of these disparities and suggest some communication strategies to increase awareness and engagement in NIST’s life sciences research.



Research Data & Computing Office (RDCO) 2026

Summer Undergraduate Research Fellowship (SURF) – 2026 Participants
Research Data and Computing Office (RDCO) - Gaithersburg

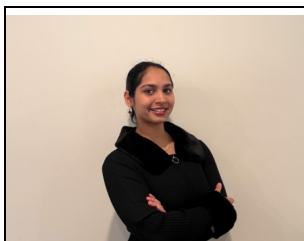
Student Names and Talk Titles (in order of presentation)

Chitpreet Kaur - Getting Instrumental: Developing a Centralized Instrument Database for Scientific Traceability

Sana Girish Rao - Streamlining the NIST Public Data Repository Collection Taxonomy Generation

Adam Zhu - Usage & Discovery Patterns of the NIST Data Repository

Lucas Rubin - The Data Integrity Project: An Ontological Approach to Research Data Integrity in the Age of Agentic AI



SURF Student Colloquium

NIST – Gaithersburg, MD

August 3-6, 2026

Name: Chitpreet Kaur

Academic Institution: University of Maryland, Baltimore County

Major: Information Systems

Academic Standing
(Sept. 2026): Graduate Student

Future Plans
(School/Career): Complete graduate school, pursue a career in Systems Analysis.

NIST Laboratory,
Division, and Group: Research Data and Computing Office (RDCO)

NIST Research Advisor: June Lau

Title of Talk: Getting Instrumental: Developing a Centralized Instrument Database for Scientific Traceability

Abstract:

What if scientific data was always Findable, Accessible, Interoperable, and Reusable? That is the promise of the FAIR principles, and it is an ideal that federal research is still working hard to live up to. We are working to make scientific results as fully reproducible as possible, and one part of achieving that comes down to better documentation of the instruments involved. When instruments are not accurately identified, or their metadata is incomplete, it becomes difficult for researchers to correlate data with instrumentation used, understand the conditions under which data was collected, and ultimately replicate results. This gap in instrument traceability is a real problem for the integrity of scientific data across federal laboratories, and NIST is no exception

To tackle this, I developed an instrument schema based on the PIDINST metadata standard (Krahl et al., 2021) and harmonized it for the NIST use code, building on the CDCS (Configurable Data Curation System) as a starting point. The result is a centralized, searchable record of scientific instruments at NIST, implemented using Python 3 and MongoDB. The database is designed around the FAIR principles so that any researcher or staff member can easily find out how it is presently configured. By imposing structure onto instrument metadata, the database reduces confusion, supports data provenance through persistent identifier (PID) integration, and helps with reproducibility.

The instrument database directly addresses the reproducibility problem by offering a snapshot of the instrument configuration as it becomes a permanent part of the record, including sub-component details, which is critical for accurately replicating scientific results. Going forward, one of the most exciting directions is pushing automation even further to cut down on errors that come from manual data entry, which is one of the most common sources of metadata mistakes. Future work could include automated syncing between various tools that catch incomplete or suspicious records before the metadata becomes a permanent part of the published dataset.

References:

Krahl, R., Darroch, L., Huber, R., Devaraju, A., Klump, J., Habermann, T., & Stocker, M. (2021). *Metadata Schema for the Persistent Identification of Instruments* (Version 1.0b1). Research Data Alliance. <https://github.com/rdawg-pidinst/schema>



SURF Student Colloquium

NIST – Gaithersburg, MD August

3-6, 2026

Name: Sana Girish Rao

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2026): Sophomore

Future Plans (School/Career): Masters in AI/ML

NIST Laboratory, Division, and Group: Research Data & Computing Office (RDCO)

NIST Research Advisor: Chandler Becker

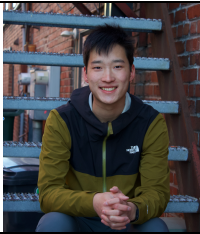
Title of Talk: Streamlining the NIST Public Data Repository Collection Taxonomy Generation

Abstract:

The NIST Public Data Repository (PDR) hosts a diverse range of data collections used by researchers and the general public. Organizing these collections with taxonomies presented in a structured dropdown format helps users navigate the many publications, records, and datasets, improving their visibility and supporting discovery. Currently, taxonomy generation is an entirely manual and lengthy process. In fact, drafting and reviewing a single taxonomy can take weeks of iterative review with subject-matter experts (SMEs) and record authors. This project aims to increase automation for the collection-specific taxonomy generation process, improving both its efficiency and thoroughness.

As a baseline, we extracted the top 100 Term Frequency-Inverse Document Frequency (TF-IDF) terms per collection from the cleaned metadata of the records in the collection to test whether statistically distinctive terms alone could form an unstructured taxonomy. Across collections, TF-IDF recovered top-level categories better than subcategories, but captured only a minority of either. These shortcomings indicate that the most appropriate terms for organizing a collection often do not appear in its records, so word frequency alone cannot surface them. Therefore, the primary approach uses large language models (LLMs) to generate structured, collection-specific taxonomies grounded substantially in semantic understanding. We implemented an API-driven pipeline to prompt RChat directly and developed and compared prompting strategies. Applied strategies include varying the number of examples (zero-shot and few-shot), the number of generations passes (single-pass and multi-pass), and models used to reduce hallucinations and produce appropriately shallow and user-centric taxonomies optimized for efficient browsing and selection. We also developed dropdown visualizations for candidate taxonomies before system integration, and spreadsheets for taxonomy comparison and evaluation.

This work supports the fundamental goal of streamlining taxonomy generation to reduce manual the required effort. The generated, visualizable taxonomies provide NIST staff with a starting point for further consideration. Ultimately, by curating collections more efficiently, the PDR can provide users with the resources they need when searching for data, improving the overall user experience on the PDR.

	SURF Student Colloquium NIST – Gaithersburg, MD August 3-6, 2026	
Name: Adam Zhu		
Academic Institution: Carnegie Mellon University		Major: Statistics and Machine Learning
Academic Standing (Sept. 2026): Sophomore		
Future Plans (School/Career): Continuing undergraduate studies		
NIST Laboratory, Division, and Group: Research Data and Computing Office (RDCO)		
NIST Research Advisor: Deoyani Nandrekar-Heinis		
Title of Talk: Understanding Usage and Discovery Patterns of the NIST Public Data Repository		
Abstract: The NIST public data repository has seen wide use over the past several years. The Resource Metadata Management (RMM) service, a REST API, is one of its main backend services, processing user queries and retrieving results from the backend database. The structured API access log files collect and store each request processed by the service. These logs contain vast amounts of operational data critical for maintaining infrastructure security and performance. However, manually analyzing these massive datasets to identify potential threats and usage patterns is highly inefficient. This project presents a machine learning-driven framework to automate log analysis, feature extraction, and request classification. ML classification methods help distinguish meaningful human usage from automated requests such as crawlers and scripts, ensuring that usage measurements reflect real interest rather than just machine traffic. Temporal analysis then reveals how access patterns shift over time, surfacing trends and periods of heightened activity. By combining these approaches, the project aims to transform log data into a clear, interpretable picture of how NIST's public datasets are accessed and discovered. The resulting insights can help NIST understand its user community, decide which datasets to prioritize and which functionalities to expand, and improve the way researchers find and use its data. This work will, in turn, provide system owners with a scalable, automated approach to log auditing and enhancing system observability.		



SURF Student Colloquium

NIST – Gaithersburg, MD August

3-6, 2026

Name: Lucas Rubin

Academic Institution: University of Maryland College Park

Major: Mathematics

Academic Standing Rising Senior
(Sept. 2026):

Future Plans I intent to pursue further data science research, or go into industry
(School/Career):

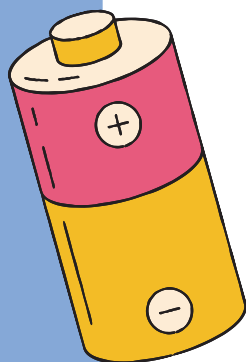
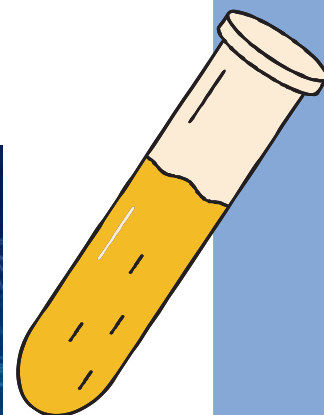
NIST Laboratory, Research Data and Computing Office
Division, and Group:

NIST Research June W Lau
Advisor:

Title of Talk: An Ontological Approach to Research Data Integrity in the age of Agentic AI

Abstract:

As Agentic AI makes its way into scientific research for the purpose of data discovery and analysis, a persistent challenge is ensuring that published research data is interpretable to these automated agents, and that these datasets are reliable and trustworthy. As it stands, materials characterization data are often distributed across disjoint or nonexistent databases, such as data repositories, instrument registries, and calibration records. The relationships between these systems are often undocumented or implicit, leaving the data difficult to interpret without specialized domain knowledge — which agentic AI lacks. This project aims to develop a prototype pipeline that bundles NIST materials characterization data into a Research Object Crate (RO-Crate): a standardized container which bundles data with machine readable metadata. The pipeline ingests information regarding a dataset, instrument reservations, specimens, and calibration records, and assigns each a type labeling. These types are contextualized by a custom OWL ontology extending W3C PROV, which defines the relationships that can hold between them. This RO-Crate is validated via SHACL shapes to ensure it meets the specifications expected by a researcher and outlined by the ontology. By representing data, provenance, and usage intent in standardized, resolvable terms, this work explores how research data can be made "self-describing" — interpretable by both humans and AI agents — while remaining honest about the current limits of provenance that the underlying systems can supply. The approach offers a path toward more discoverable, reusable, and trustworthy materials data within an open-science framework.



Technology Partnerships Office (TPO) 2026



Summer Undergraduate Research Fellowship (SURF) – 2026 Participants

Technology Partnerships Office (TPO) - Gaithersburg

Student Names and Talk Titles (in order of presentation)

Kristina Fleck - Technology Transfer Comparative Case Analysis

Joy Ghosh