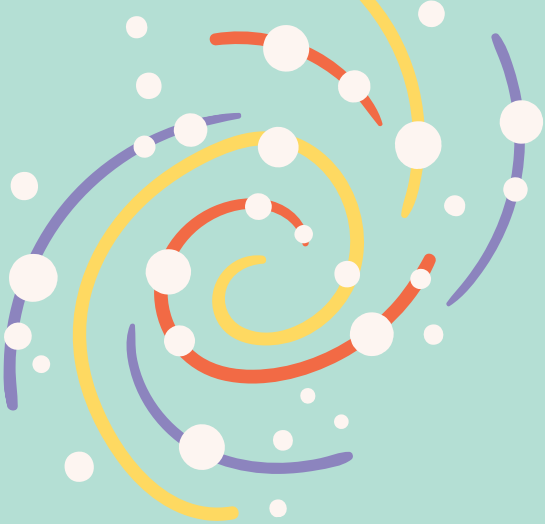
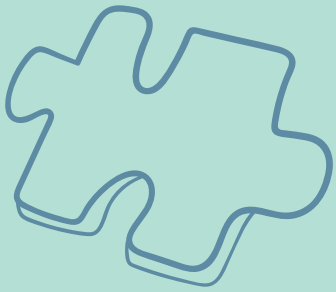
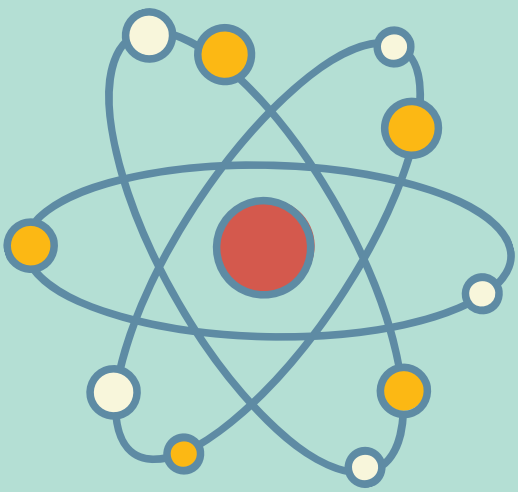




NIST | SUMMER UNDERGRADUATE RESEARCH FELLOWSHP

SURF 2024



Greetings,

On behalf of the Director's Office, I proudly present the 2024 SURF Colloquium book. Using a hybrid format, the 2024 SURF Program featured 152 in-person and virtual participants.

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 2024 cohort, representing all STEM disciplines, included 152 participants from over 90 universities working on research projects on the NIST campuses in Boulder, CO, Gaithersburg, MD, Waimanalo, HI, and remotely. Participants from all campuses engaged in activities collectively, including the Colloquium. In the future, the program will likely include virtual and in-person components regularly as we adapt to the nation’s changing workforce is changing.

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 individuals who make the SURF Program possible. Thank you to the Laboratory SURF Directors, the SURF mentors, the administrative staff, OISM, 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.

I hope you enjoy the 2024 Colloquium and learn something new about the nation’s standards laboratory.

Best regards,

Cara O'Malley

Cara O'Malley

NIST SURF Program Director

2024 NIST SURF Program Team	
Name	**Organizational Unit (OU)/Office**
*Cara O'Malley	International & Academic Affairs Office (IAAO)
LaKesha Perry	International & Academic Affairs Office (IAAO)
Lotfi Benmohamed	Communication Technology Laboratory (CTL)
*Chris Carson	Communication Technology Laboratory (CTL)
Wesley Garey	Communication Technology Laboratory (CTL)
David Griffith	Communication Technology Laboratory (CTL)
Joyce Malones	Communication Technology Laboratory (CTL)
Jian Wang	Communication Technology Laboratory (CTL)
Kathleen Hoffman	Engingeering Laboratory (EL)
Cartier Murrill	Engingeering Laboratory (EL)
Melissa Banner	Information Technoloby Laboratory (ITL)
Yolanda Bursie	Information Technoloby Laboratory (ITL)
Katya Delak	Information Technoloby Laboratory (ITL)
Gunay Dogan	Information Technoloby Laboratory (ITL)
Michaela Iorga	Information Technoloby Laboratory (ITL)
Derek Juba	Information Technoloby Laboratory (ITL)
Gini Khalsa	Information Technoloby Laboratory (ITL)
Katherine Schroeder	Information Technoloby Laboratory (ITL)
Ian Soboroff	Information Technoloby Laboratory (ITL)
Simon Su	Information Technoloby Laboratory (ITL)
*Wendi Copello	Materials Measurement Laboratory (MML)
Kathryn (Arden) Coogan	Materials Measurement Laboratory (MML)
Katherine Gettings	Materials Measurement Laboratory (MML)
Nathan Mahynski	Materials Measurement Laboratory (MML)
Jacqueline (Jackie) Mann	Materials Measurement Laboratory (MML)
Mark McLean	Materials Measurement Laboratory (MML)
Jessica (Jess) Staymates	Materials Measurement Laboratory (MML)
Julie Borchers	NIST Center for Neutron Reseach (NCNR)
Mary Ann Fitzgerald	NIST Center for Neutron Reseach (NCNR)
Leland Harriger	NIST Center for Neutron Reseach (NCNR)
Yimin Mao	NIST Center for Neutron Reseach (NCNR)
Susana Teixeira	NIST Center for Neutron Reseach (NCNR)
Uwe Arp	Physical Measurement Laboratory (PML)
Toni Litorja	Physical Measurement Laboratory (PML)
Katelyn Goetz	Physical Measurement Laboratory (PML)
Theresa Ginley	Physical Measurement Laboratory (PML)
Amy Grafmuller	Physical Measurement Laboratory (PML)
Zachary Levine	Physical Measurement Laboratory (PML)
*Matt Pufall	Physical Measurement Laboratory (PML)
*Mitch Wallis	Physical Measurement Laboratory (PML)
Michael (Mike) Berilla	Management Resources (MR)
Lisa Fronczek	Office of Advanced Manufacturing (OAM)
Nathalie Rioux	Standards Coordination Office (SCO)
*Based in Boulder, CO	

Table of Contents

SURF Colloquium
One-NIST Plenary Session
Tuesday, August 13, 2024
Gaithersburg Green Auditorium, Boulder Bldg 81 Rm 1A116

Zoom Link: https://nist.zoomgov.com/j/1604547403?pwd=dGloVWpNTlZCWlNhMm1hMVN4ZzRhUT09;

Meeting ID: 160 454 7403; Passcode: 443943

9:45 AM ET	**Welcome Remarks & Gaithersburg Moderator :** *Cara O'Malley* **Boulder Moderator:** *Susan Schima* **Zoom Moderator:** *Cartier Murrill*

TIME (ET)	Pleanary Speaker and OU	Presentation Title
9:55 AM	*Nathan Wei* - **CTL**	Supporting UDP Communications for a Real-Time Control Robotic Application
10:20 AM	*Emma Bair* - **EL**	Application of Standards: Designing a CMM Digital Twin
10:45 AM	*William Lee* - **ITL**	Image restoration to improve face recognition outcomes – Does it really work (and how do we know)?
11:10 AM	*Peter Anderson* - **MML**	Textile Sorting Algorithms using Near Visible Infrared Spectroscopy towards Circular Economy
11:35 AM	BREAK	N/A
11:50 AM	*Veronica Ivanovskaya* - **NCNR**	Development of Lipid-Based Scaffolds with Extracellular Matrix Proteins for Tissue Repair
12:15 PM	*Bianca Meurer-Zeman* - **PML (Boulder)**	Optimization of Magnetic SMART Hydrogel Sensor for Increased Sensitivity
12:40 PM	*Michelle Crouse* - **Boulder speaker - CTL**	Developing Acoustic Absorption Metrology in Liquids
1:05 PM	LUNCH	N/A

Parallel Sessions - Tuesday, Aug 13, 2024

	Parallel Session #1	Parallel Session #2	Parallel Session #3
Location	**Gaithersburg Heritage Room** **Boulder Bldg 1, Rm 1107** **- attendees speak out loud to ask questions**	**Gaithersburg, Bldg 101, Lecture Room B** **Boulder Bldg 2, Rm 0113** **- attendees speak out loud to ask questions**	**Gaithersburg LR-D** **Boulder Bldg 1, Rm 1203D (8-10 people)** **- attendees speak out loud to ask questions**
Zoom Links	**https://nist.zoomgov.com/j/1604547403?pwd=dGloVWpNTlZCWlNhMm1hMVN4ZzRhUT09; Meeting ID: 160 454 7403; Passcode:**	**https://nist.zoomgov.com/j/1615176738?pwd=bFREOWxNUnpxMjY0ektON3M4eEhXUT09; Meeting ID: 161 517 6738; Passcode: 652540**	**https://nist.zoomgov.com/j/1612668048?pwd=ODM5OWJ0clJTc1RQWE9KQ2FaSnFqUT09; Meeting ID: 161 266 8048; Passcode: 748934**
Host Info	**Host Laboratory: PML** **Moderator:** *Zach Levine* **Zoom Moderator:**	**Host Laboratory: MML** **Moderator:** *Sam Webster* **Zoom Moderator:** *Jackie Mann*	**Host Laboratory: EL** **Moderator:** *Joannie Chin* **Zoom Moderator:** *Cartier Murrill*
1:45 PM ET	*Neeltje Kackar:* Enhancing Firearm Toolmark Analysis with AI-Optimized Image Segmentation and Classification	*Sasha Menchaca:* High-Speed In-Situ X-ray Imaging of Powder Particle Behavior in Laser Powder-Blown Directed Energy Deposition	*Christian Farias* : Communications and Science: Illustrating Ingenuity
2:00 PM ET	*Anthony Karoly:* A Noise-Reduction Toroidal Transformer for Improvemetns in Magnetic Particle Imaging Technology	*Annabel Shim:* The Effect of Laser Beam Shape on Material Structure in Directed Energy Deposition	*Juan Carlos Guana:* Multi-Label Classification of Disaster Tweets using Transformer-based and Deep Learning
2:15 PM ET	*Mingxin Lei* : Pressure Shifts and Broadening of Electromagnetically Induced Transparency in Rubidium Rydberg Atoms	*Ian Fagan* : Software Development for the IUPAC "Adsorption Information Format"	*Anna Liu:* Climate Change and Resilience Sentiments Following a Natural Event
2:30 PM ET	*Matthew Miller* : Generation and Control of Magnetic Fields for the Laser Slowing of MgF Molecules	*Austyn Nguyen* : Developing a FAIR-compliant Metadata Standard for Phase Field Data using Semantic Web Resources	*Timothy Jacob:* Insights on Emergency Communication Protocol and Standards
2:45 PM ET	**BREAK**	**BREAK**	**BREAK**
Host Info	**Host Laboratory: PML** **Moderator:** *Theresa Ginley* **Zoom Moderator:**	**Host Laboratory: MML** **Moderator:** *Feng Yi* **Zoom Moderator:** *Jackie Mann*	**Host Laboratory: EL** **Moderator:** *Goudong Shao* **Zoom Moderator:**
3:00 PM ET	*Jeremy Robin:* Building a Portable Laser System for the Cold Atom Vacuum Standard	*Nishwanth Gudibandla:* Tuning the magnetic properties of two-dimensional (2D) VxTi1-xSe2 through Alloying	*Julie Aleiner:* Degradation Mechanisms and Failure Mode of Photovoltaic Polymeric Backsheets
3:15 PM ET	*Matthew Boone* : A Flexure Stage to Characterize Voice Coil Actuators in Tabletop Kibble Balances	*Abigail Antonishek:* Evaluation of NISTmAb Peptide Mapping Precision and Method Transfer	*James Alzona:* Development of non-destructive polymer degradation measurements for photovoltaic backsheets
3:30 PM ET	*Leiyla Brent* : Optimization of the Calibration Source for a High-Resolution x-ray Spectrometer at the NIST EBIT	*Leonardo Borchert* : FE Analysis of Elastic Indentation Deformation of Layered Structures in Advanced Packaging	*Varadraj Chavan:* The Marine Microplastic Mayhem: Studying Plastic Degradation in Aquatic Environments
3:45 PM ET	*Zoe Fong* : Measuring Dynamic Quantities of the Kibble Dynamic Force Reference	*Arden Dombalagian* : Data Acquisition and Analysis of Differential Nanocalorimetry	***virtual -** *Natanel Solomonov* : Verfication and Validation of Computational Models for Analyzing Future Impacts of Sea Level Rise
4:00 PM ET	***virtual, Boulder -** *Katherine Ellis* : Monte Carlo Modeling for Nanoscale X-ray Tomography of Nanoelectronics	*Joanna Li* : Differential Nanocalorimetry Circuit Measurements	*Sarah Lehrman:* Analysis of Fiber Reinforced Polymer (FRP) Retrofitted Shear Walls with Openings
4:15 PM ET	**BREAK**	**BREAK**	**BREAK**
Host Info	**Host Laboratory: PML** **Moderator:** *Angie Hight Walker* **Zoom Moderator:** *Richard Steiner*	**Host Laboratory: MML** **Moderator:** *Diana Ortiz-Molvano* **Zoom Moderator:** *Mark McLean*	**Host Laboratory: EL** **Moderator:** *Xiaohong Gu* **Zoom Moderator:**
4:30 PM ET	*Julia Kanamine-Surrick:* Advancing Magneto-Optical Spectroscopy for Quantum Materials Through Automation	*Jace Bell:* Developing Methods to Detect Microplastics Released from Facial Scrubs	***virtual -** *Samantha Farren: A Study of Concrete Materials using Optical Microscopy and X-ray Diffraction*
4:45 PM ET	*Elina Lee:* Time-of-flight and X-ray Spectra of a 0.7-Tesla mini-EBIT	*Selana Kurutan* : Evaluating Separation Efficiency of Secondary Micro and Nanoplastic Controls to Improve Particle Identification and	***virtual** - *Benjamin Johnsson:* Effects of Sealants on Concrete Permeability
5:00 PM ET	*Alan Zhu:* A Tabletop Electromagnetic Force Measurement for Small Mass Measurement	***virtual, HI** - *Susannah Armstrong:* Characterization of Recycled Plastic Products for Asphalt Paving Applications	*Jacqueline Stensland:* Reactivity and Expansion of Iron Sulfides in Cement
5:15 PM ET	*Andrew Nupp:* Substrate Optimization in Drop-on-Demand Inkjet Printing for Autoradiography Calibration Phantoms	***virtual, HI** - *Remi Mellinghoff:* The Rate of Chemical Changes during Outdoor Sunlight Weathering of Polyamide Pellets	*Nelson Tucker:* Developing a Database of Tornado Strikes on Warehouse-Type Structures
5:30 PM ET	**END for the Day**	**END for the Day**	**END for the Day**

Parallel Sessions - Wednesday, Aug 14, 2024

	Parallel Session #1	Parallel Session #2	Parallel Session #3
Location	**Gaithersburg Heritage Room** **Boulder Bldg 1, Rm 1107** **- attendees speak out loud to ask questions**	**Gaithersburg, Bldg 101, Lecture Room B** **Boulder Bldg 2, Rm 0113** **- attendees speak out loud to ask questions**	**Gaithersburg Lecture Room D** **Boulder Bldg 1, Rm 1203D (8-10 people)** **- attendees speak out loud to ask questions**
Zoom Links	**https://nist.zoomgov.com/j/1604547403?pwd=dGloVWpNTlZCWlNhMm1hMVN4ZzRhUT09; Meeting ID: 160 454 7403; Passcode: 443943**	**https://nist.zoomgov.com/j/1615176738?pwd=bFREOWxNUnpxMjY0ektON3M4eEhXUT09; Meeting ID: 161 517 6738; Passcode: 652540**	**https://nist.zoomgov.com/j/1612668048?pwd=ODM5OWJ0clJTc1RQWE9KQ2FaSnFqUT09; Meeting ID: 161 266 8048; Passcode: 748934**
Host Info	**Host Laboratory: PML** **Moderator:** *Brittany Broder* **Zoom Moderator:** *Denis Bergeron*	**Host Laboratory: MML** **Moderator:** *McKenzie Coughlin* **Zoom Moderator:** *Nate Mahynski, Jess Staymates*	**Host Laboratory: CTL** **Moderator:** *Wesley Garey* **Zoom Moderator:** *Jian Wang*
9:00 AM ET	*Eva Rissanen:* Building a Cryogenic Amplifier Means Chilling Out for Low Noise and High Sensitivity	*Allison Caranza:* Chemical Recycling of Polyester Based Textiles	*Themla Caplan* : Establishing Zero Trust in O-RAN
9:15 AM ET	*Alisha Patel* : Comparison of Yttrium-90 Radioactivity Measurements with TOPAS Simulations	*Eliana Szabo:* Effects of Thermal History on Semicrystalline Morphology of Polypropylene During Fused Filament Fabrication	*Niolas Carbone* : Collecting and Analyzing Data from a Manufacturing Testbed
9:30 AM ET	*Christina Addison* : Development of Graphene Biosensors for Exosome Quantification in a Heart-on-a-Chip System	*Caitlyn Edgar:* Shear Rate Dependence of Polyolefin Blend Morphology	*Nihar Kapasi* : Simulation and Modeling of Future Wireless Communication Systems
9:45 AM ET	*Nidhi Nagashankar* : Cell Counting In Flow Cytometry	*Nuelle Johnson:* Using Time-gated (TG) Raman to Characterize Marine Plastic Pollution from Hawaii	*Andrew Oxenberg* : File Isolation and Dependency Mapping for STEP Standards in EasyEXPRESS
10:00 AM ET	*Shannon Newell* : Using Solid State Silicon Nitride Nanopores to Assess the Effects of Irradiation on DNA	***virtual** - *Hayden Brandt:* Characterization of the Picosecond Dynamics of Polycarbonate using Coarse-Grained Molecular Dynamics (MD) Simulations	*Kevin Song* : Developing a Graphical Data Analysis Tool for SimPROCESD
10:15 AM ET	**BREAK**	**BREAK**	**BREAK**
Host Info	**Host Laboratory: PML** **Moderator:** *Daniel Barker* **Zoom Moderator:**	**Host Laboratory: MML** **Moderator:** *Trina Mouchahoir (proposed)* **Zoom Moderator:** *Nate Mahynski*	**Host Laboratory: CTL** **Moderator:** *Wesley Garey* **Zoom Moderator:** *Jian Wang*
10:30 AM ET	*Addhyaya Sharma:* Creating Silicon Vacancies in Silicon Carbide for Quantum-Enhanced Nanopore Sensing	*Maya Reid:* Surface Variants of the NISTmAb	*Benjamin Winig:* Creating Data Management Foundations for a Simulated Manufacturing Environment
10:45 AM ET	*Dinelka Jagoda:* Expanding SI Educational Outreach Resources	*Sonia Ghoshal* : Removing Diffraction from X-ray Fluorescence Spectra for HfO2 Thin Film Characterization	*Tyler Wong* : Software Development for Internet of Things (IoT) Device Interoperability Analysis
11:00 AM ET		*Ben Wenig:* Characterization Methods for Isotopic Trace Labeling of Cellulose Nanomaterials	*Howard Dai* : ML-Based Multipath Component Extraction and False Detection Recognition
11:15 AM ET		***virtual** - *Rebecca Diaz* : Structure Refinement of Nucleic Acids	*Mikelley Baptiste:* Special Project - IAAO Program Engagement Resources
11:30 AM ET			
11:45 AM ET	**LUNCH**	**LUNCH**	**LUNCH**
Location-different	**Gaithersburg: Portrait Room**	**Same location as morning sessions**	**Same location as morning sessions**
Host Info	**Host Laboratory: ITL** **Moderator:** *Brian Cloteaux* **Zoom Moderator:** *Simon Su*	**Host Laboratory: MML** **Moderator:** *David Raciti* **Zoom Moderator:** *Nate Mahynski*	**Host Laboratory: EL** **Moderator:** *Jason Averill* **Zoom Moderator:** *Cartier Murrill*
12:45 PM ET	*Mikhail Krepets:* Walk on Spheres Improvements for ZENO	*Preston Connors* : Measurement Methods for Carbon in Cements	*Sydney Holles:* Investigating Building Performance Using CX Software
1:00 PM ET	*Davis Ford:* Speeding Up TestU01 with Threads	*Maximilian Niebur:* Mapping Synthesis Landscapes for Metal-Organic Frameworks for Carbon Capture	***virtual** - *Kelsi Wood:* Custom Digital Building Twins 3D Models to Graphs
1:15 PM ET	*Faadil Shaikh:* Studying the Effects of Using Triangular Meshes in ZENO on Accuracy and Speed	*Samuel Bentz:* Ceramic 3D Printing: From Slurry to Sintered Part	*Weiheng Oh:* Pressure Loss in Pipe Fittings / Condensation of Two-phase Flow in Microchannels
1:30 PM ET	*Daniel Choi:* Photoluminescence Mapping of Vanadium Defects in SiC for Quantum Technology Application	*Charles Mann:* Understanding the Role of Nitrogen Content on Performance of 17-4PH Stainless Steel	*Helen Catan:* Testing and Analysis of Material Flammability through the Cone Calorimeter
1:45 PM ET	Irving Shi: Creating a Power Grid Topology Simulation	*Vincent Tsai:* Curved gratings for use in X-ray grating interferometry	*Philip Huang:* Operation/Automation of TGADSC and Construction of Intermediate Scale Flame Spread Apparatus
2:00 PM ET	**BREAK**	**BREAK**	**BREAK**
	AFTERNOON SCHEDULE CONTINUES ON NEXT PAGE		

Parallel Sessions - Wednesday, Aug 14, 2024 (continued)

	Parallel Session #1	Parallel Session #2	Parallel Session #3
Location	**Gaithersburg: Portrait Room** **Boulder Bldg 1, Rm 1107** **- attendees speak out loud to ask questions**	**Gaithersburg, Bldg 101, Lecture Room B** **Boulder Bldg 2, Rm 0113** **- attendees speak out loud to ask questions**	**Gaithersburg Lecture Room D** **Boulder Bldg 1, Rm 1203D (8-10 people)** **- attendees speak out loud to ask questions**
Zoom Links	**https://nist.zoomgov.com/j/1604547403?pwd=dGloVWpNTlZCWlNhMm1hMVN4ZzRhUT09;** **Meeting ID: 160 454 7403; Passcode: 443943**	**https://nist.zoomgov.com/j/1615176738?pwd=bFREOWxNUnpxMjY0ektON3M4eEhXUT09;** **Meeting ID: 161 517 6738; Passcode: 652540**	**https://nist.zoomgov.com/j/1612668048?pwd=ODM5OWJ0clJTc1RQWE9KQ2FaSnFqUT09;** **Meeting ID: 161 266 8048; Passcode: 748934**
2:00 PM ET	**BREAK**	**BREAK**	**BREAK**
Host Info	**Host Laboratory: ITL** **Moderator:** *Leroy Jia* **Zoom Moderator:** *Simon Su*	**Host Laboratory: NCNR** **Moderator:** *Shadi Mamaghani, NSF* **Zoom Moderator:** *Nate Mahynski*	**Host Laboratory: EL** **Moderator:** *Lisa Fronczek* **Zoom Moderator:**
2:15 PM ET	*Shawn Pourifarsi:* Exploring and Addressing the Limitations of Shaders in Paraview	*Sean Johnson:* Characterizing the Stability of Surfactant-preservative Mixtures for Pharmaceutical Use	*Alec Tripi:* Development of the Molecular Weight Apparatus and Construction of the CAPA II
2:30 PM ET	*Lilian Xiao:* Improving Lighting in Immersive 3D Scientific Visualization	*Thomas Murray (CORE):* Globular Protein Assembly in Bulk Solution and at the Air/Water Interface: Effect of Silicone Oil	*Shine Park:* Measuring Soot Deposition on Surfaces Using Grayscale Image Analysis
2:45 PM ET	*Alexander Liu:* Extending Tools for Physical Measurement in Virtual Environments in Paraview	*Xael Shan (CORE):* Analyzing the Structure of Bicelles with Small Angle Neutron Scattering and Sasview	*Nihar Xavier:* Using the Fire Dynamics Simulator (FDS) to Evaluate Wildfire Model Accuracy at Varying Complexities
3:00 PM ET	*Sydney Lee:* Enhancing cytometer data collection with a high-speed neuromorphic camera	*Marshall Butler:* Impact of Process Parameters on Soft Nanoparticle Formulations for Capillary Rheology Studies	*Kyle Foster:* Adapting the Bass Diffusion Model to Forecast Critical Material Demands for Clean Energy Technologies
3:15 PM ET	*William Deye:* Radial Basis Functions and Biological Field Effect Transistors		*McCarthy Devine:* Developing and Practicing Standard Methods for Emergency Response Drones
3:30 PM ET	**BREAK**	**BREAK**	**BREAK**
Host Info	**Host Laboratory: ITL** **Moderator:** *Derek Juba* **Zoom Moderator:** *Yolanda Bursie*		**Host Laboratory: EL** **Moderator:** *Cartier Murrill* **Zoom Moderator:**
3:45 PM ET	*Thomas Wolcott:* Using Discrete Variable Representation to Solve the 1D TDSE		*Ethan Nowery:* Testing Terrain Traversal, Dexterity, and Visual Acuity of Legged and Tracked Ground Robots
4:00 PM ET	*Evan Liu:* Measurements from Event-based and Frame-based Cameras		*Eric Eng:* Techniques for Recognition of Static Rotation Invariant Gestures
4:15 PM ET	*Akhilesh Reddy:* Mapping Uncertainty for Image Classification		*Terrence Pierce :* Evaluating 3D Sensor performance usiong planar targets
4:30 PM ET	*Anna Li:* Exploring the Use of Digital Twins to Generate Ground Truth for AIs		*Tiegan Powell:* Investigating Shape-From-X Programs for Object Geometry Reconstruction
4:45 PM ET	*Jeffrey Howard:* Standards as Discourse		*Beck Tappert:* Bridging the Gap between Robotics Research and the Standard Industial Robotic Work Cell
5:00 PM ET	**END for the Day**	**END for the Day**	**END for the Day**

Parallel Sessions - Thursday, Aug 15, 2024

	Parallel Session #1	Parallel Session #2	Parallel Session #3	Parallel Session #4
Location	**Gaithersburg: Bldg 101, Heritage Rm** **Boulder Bldg 1, Rm 1107** **- attendees speak out loud to ask questions**	**Gaithersburg: Bldg 101, LR-B** **Boulder Bldg 2, Rm 0113** **- attendees speak out loud to ask questions**	**Gaithersburg: Bldg 101, LR-D** **Boulder Bldg 1, Rm 1203D** **- attendees speak out loud to ask questions**	**Boulder: Bldg 81, Rm 1A116** **Gaithersburg: Bldg 101, LR-C** **- attendees speak out loud to ask questions**
Zoom Links	**https://nist.zoomgov.com/j/1604547403?pwd=dGloVWpNTlZCWlNhMm1hMVN4ZzRhUT09; Meeting ID: 160 454 7403; Passcode: 443943**	**https://nist.zoomgov.com/j/1615176738?pwd=bFREOWxNUnpxMjY0ektON3M4eEhXUT09; Meeting ID: 161 517 6738; Passcode: 652540**	**https://nist.zoomgov.com/j/16126680048?pwd=ODM5OWJ0clJTc1RQWE9KQ2FaSnFqUT09; Meeting ID: 161 266 8048; Passcode: 748934**	**https://nist.zoomgov.com/j/1610203542?pwd=mCuysyFRl2JUsa55YOYkESarebd0Zk.1; Meeting ID: 161 020 3542; Passcode: 768320**
Host Info	**Host Laboratory: ITL** **Moderator:** *Katya Delak* **Zoom Moderator:** *Yolanda Bursie*	**Host Laboratory: MML** **Moderator:** *Liz Robinson and Tom Forbes* **Zoom Moderator:** *Katherine*	**Host Laboratory: NCNR** **Moderator:** *Guebre Tessema, NSF* **Zoom Moderator:** *Leland Harriger*	This is the ***SURF BOULDER COLLOQUIUM;*** starting at 11:55 am ET/9:55 am MT
9:00 AM ET	*Marianne Nguyen:* Web App for Measurement Error Models	*Victoria Chazin:* Evaluating the Recovery of Exogenous Viral Material Spiked into Real Collected Wastewater Samples	*Adam Friedland:* Magnetoelectric coupling in bulk single crystals of PMN-PT	
9:15 AM ET	*Andrew Zhang:* Advancing Deepfake Defense: Building a Comprehensive Generative-AI Detection Dataset	*Elizabeth Hackley:* Characterization and Correction of Measurement Biases in Microfluidic Chip-Based Resistive Pulse Sensing for Small Extracellular Vesicle Analysis	*Talya Lebson:* Using Chemical Vapor Depostion to Grow Thin Film Actinide Compounds	
9:30 AM ET	*Vicky Lee:* Judging Large Language Models on Generating Relevance Judgements	*Zainab Altamimi:* Investigating Drug Vehicles for Point-of-Care Drop-on-Demand Pharmaceutical Manufacturing	*Archana Parameswaran:* Resolving the Spin Structure of Magnetic Topological Crystal NdSb Using Inelastic Neutron Scattering	
9:45 AM ET	*Francis Durso:* Optimizing Data Binning for Enhanced Accuracy in Classification Algorithms	*Olivia Agolini:* Point-of-Care Pharmaceutical Manufacturing: Tailored Dosing for Personalized Medicine	*Patrick Chen:* Characterizing Weyl-mediated Magnetic Interactions in Non-centrosymmetric Rare-earth Materials	
10:00 AM ET	*Shraddha Hardikar:* Neural-Network Based Cryptanalysis	*Austin Vest* : Quantifying the Environmental Degradation of Trace Drug Residues Using Mass Spectrometry	*Elizabeth Baggett:* Using AI to Classify Crystal Structure from Powder Diffraction Using Over 1,000,000 Patterns	
10:15 AM ET	**BREAK**	**BREAK**	**BREAK**	
Host Info	**Host Laboratory: ITL** **Moderator:** *Michaela Iorga* **Zoom Moderator:** *Yolanda Bursie*	**Host Laboratory: MML** **Moderator:** *Jamie Weaver* **Zoom Moderator:** *Katherine Gettings*	**Host Laboratory: NCNR** **Moderator:** *Guebre Tessema, NSF* **Zoom Moderator:** *Leland Harriger*	
10:30 AM ET	*Megha Jasti:* Implementing m-NGAC in Oracle for Off-the-Shelf Fine-Grained Access Control	*Samuel Chen:* Impact of Preprocessing on Machine Learning Tools for HRTEM Research	*Sophia Rankin:* Quantification of Bubble Defects Within Candidate Standard Reference Material Glasses	
10:45 AM ET	*Madison Catterton:* Creating and Securing a NLP tool for the NCCoE website	*Halen Solomon* : Small-volume Characterization of Solutions using On-demand, Droplet-generating Microfluidics	*Zoe Masters:* Development of an Intelligent Monitoring System for the Cold Neutron Source Cryogenics System	
11:00 AM ET	*Miles Walker:* A Case Based Human Reliability Assessment Using the Human Factors Analysis and Classification System (HFACS) Framework for the Systems Security Management Work Role	***virtual** - *Leonardo Buitrago* : A Legal Linguistic and Evidence-based Approach to Improve BBD Webpage AI Readiness	*Alex Caldanaro:* Configuration Management of the National Bureau of Standards Reactor	
11:15 AM ET	*Joey See:* Area-based Trojan Prevention for Open Source Silicon Design	*Theresa Thomas:* What's the Big Idea? Expanding Scientific Communications for MML Programs	*Iman Syed:* Verification of Thermal-Hydraulics Models for Nuclear Reactors with Plate-Type Fuels	
11:30 AM ET	*Christopher Su:* Power Side Channel Analysis	*Peter Winstel* : High Throughput Calculations for Determining Liquid Properties	*Eric Swanson:* NIST Neutron Source Initial Startup Core Loading Analysis	
11:45 AM ET	**END of Parallel Session #1** **Join Parallel Session #4 at noon ET**	**END of Parallel Session #2** **Join Parallel Session #4 at noon ET**	**END of Parallel Session #3** **Join Parallel Session #4 at noon ET**	**START of Parallel Session #4**

AFTERNOON SCHEDULE CONTINUES ON NEXT PAGE

Parallel Sessions - Thursday, Aug 15, 2024 (continued)

SURF BOULDER COLLOQUIUM - Parallel Session #4

Parallel Sessions #1-3 are finished - Join Parallel Session #4 at noon ET

Location	**Boulder: Bldg 81, Rm 1A116**	**Gaithersburg: Bldg 101, LR-C** **- attendees speak out loud to ask questions**
Zoom Link	**https://nist.zoomgov.com/j/1610203542?pwd=mCuysyFRl2JUsa55YOYkESarebd0Zk.1; Meeting ID: 161 020 3542; Passcode: 768320**	
Host Info		**Host Laboratory: SURF Boulder**
		Moderator: *Lincoln Queale*
		Zoom Moderator: *Michelle Crouse*
11:55 AM ET	**9:55 AM MT**	**Boulder Colloquium - Welcome Remarks:** *Cara O'Malley & Susan Schima*
12:00 PM ET	**10:00 AM MT**	*Matthew S. Ai* : Optical Homodyne Tomography to Reconstruct Squeezed States for Quantum Networking
12:15 PM ET	**10:15 AM MT**	*Zachary Miles* : Development of a Superconducting Microwave Resonator Open-source Codebase
12:30 PM ET	**10:30 AM MT**	*Robert Harper* : TKID Simulations Using Geant4 and G4CMP
12:45 PM ET	**10:45 AM MT**	*Benjamin O. Nienhouse* : Adaptable HALO Design for High Power Laser Calibrations
1:00 PM ET	**11:00 AM MT**	**LUNCH BREAK**
Host Info		**Moderator:** *Benjamin Nienhouse*
		Zoom Moderator: *Ala Bazyleva*
2:00 PM ET	**12:00 PM MT**	***virtual** - *Ryan Mapes* : Ask the Magic Conch: Using Machine Learning to Improve Statistical Estimator Accuracy
2:15 PM ET	**12:15 PM MT**	*Gregory Wickham* : Estimating ROC Curves Assuming Multiplicative Noise that is Generalized Gamma Distributed
2:30 PM ET	**12:30 PM MT**	*Lincoln Queale* : Statistical Modeling of High-Cycle Metal Fatigue Data
2:45 PM ET	**12:45 PM MT**	*Grace Boyer* : Improving Encoding Algorithms for GC-MS Analysis in Forensic Fire Debris Research
3:00 PM ET	**1:00 PM MT**	*Elliot Topper* : LOD Calculator: A Web Application to Compute Limits of Detection
3:15 PM ET	**1:15 PM MT**	**BREAK**
Host Info		**Moderator:** *Michelle Crouse*
		Zoom Moderator: *Benjamin Nienhouse*
3:30 PM ET	**1:30 PM MT**	*Gabriella Erich* : Development of Magnetic Nanoparticles for Low-field Magnetic Resonance Imaging
3:45 PM ET	**1:45 PM MT**	*Eric Johnson* : Development of Radiation Sensitive Gels for MRI Based 3D Dosimetry
4:00 PM ET	**2:00 PM MT**	*Conor Wellman* : Internet Clock Synchronization Algorithms Using Clock Statistics
4:15 PM ET	**2:15 PM MT**	*Vallabh Kudva* : Method Development and Best Practices for Atomic Clock Metrology
4:30 PM ET	**2:30 PM MT**	**END of Parallel Session #4**

End OF 2024 SURF Colloquium

THANK YOU! CONGRATULATIONS!

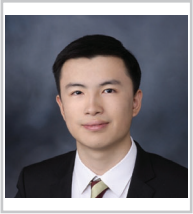
Boulder, CO
2024

Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Boulder, CO

Bianca Meurer-Zeman (PML) - **PML plenary speaker**	Optimization of Magnetic SMART Hydrogel Sensor for Increased Sensitivity
Michelle Crouse (CTL) **- Boulder plenary speaker**	Developing Acoustic Absorption Metrology in Liquids
Katherine Ellis (PML)	Monte Carlo Modeling for Nanoscale X-ray Tomography of Nanoelectronics
Matthew S. Ai (CTL)	Optical Homodyne Tomography to Reconstruct Squeezed States for Quantum Networking
Zachary Miles (PML)	Development of a Superconducting Microwave Resonator Open-source Codebase
Robert Harper (PML)	TKID Simulations Using Geant4 and G4CMP
Benjamin O. Nienhouse (PML)	Adaptable HALO Design for High Power Laser Calibrations
Ryan Mapes (ITL)	Ask the Magic Conch: Using Machine Learning to Improve Statistical Estimator Accuracy
Gregory Wickham (ITL)	Estimating ROC Curves Assuming Multiplicative Noise that is Generalized Gamma Distributed
Lincoln Queale (ITL)	Statistical Modeling of High-Cycle Metal Fatigue Data
Grace Boyer (ITL)	Improving Encoding Algorithms for GC-MS Analysis in Forensic Fire Debris Research
Elliot Topper (ITL)	LOD Calculator: A Web Application to Compute Limits of Detection
Gabriella Erich (PML)	Development of Magnetic Nanoparticles for Low-field Magnetic Resonance Imaging
Eric Johnson (PML)	Development of Radiation Sensitive Gels for MRI Based 3D Dosimetry
Conor Wellman (PML)	Internet Clock Synchronization Algorithms Using Clock Statistics
Vallabh Kudva (ITL)	Method Development and Best Practices for Atomic Clock Metrology



SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Matthew S. Ai
Academic Institution:	University of Southern California (USC)
Major:	Electrical and Computer Engineering
Academic Standing (Sept. 2024):	Incoming first-year graduate student at Princeton University
Future Plans (School/Career):	Starting this fall, I am pursuing a Ph.D. in in Quantum Science and Engineering (QSE) at Princeton
NIST Laboratory, Division, and Group:	Communications Technology Lab, RF Technology Division, High Speed Waveform Metrology Group
NIST Research Advisor:	Dr. Tasshi Dennis
Title of Talk:	Optical Homodyne Tomography to Reconstruct Squeezed States for Quantum Networking

Abstract:

In this project, we experimentally implemented optical homodyne tomography to characterize squeezed states of light, a building block for creating optical interconnects between superconducting quantum computers. Networking separate superconducting processors via interconnects could enable us to scale our quantum computers beyond current physical limitations. Our optical homodyne tomography system uses repeated measurements of a light field to reconstruct a statistical estimate of the light's quantum state; accurate characterization of these states allows us to assess the quality of the entanglement we generate as a quantum resource critical to network operation. We built a Mach-Zehnder interferometer for initial optical alignment, and we set up a homodyne balanced detection scheme to measure field quadratures and characterize quantum noise. In this talk, we show how we use a maximum likelihood estimation algorithm and the measured homodyne data to tomographically reconstruct various quantum states. We discuss experimental measurements verifying a one-mode squeezed state with our tomographic apparatus, as well as how this system can be applied towards entanglement verification of two-mode squeezed light used to connect two quantum network nodes.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

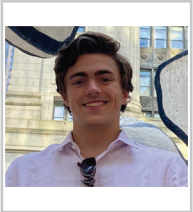
Name: Grace Boyer		
Academic Institution: Eastern Kentucky University	**Major:** Forensic Science	
Academic Standing (Sept. 2024):	Junior	
Future Plans (School/Career):	Work in a forensic position at the federal or state level	
NIST Laboratory, Division, and Group:	ITL, Statistical Engineering Division, Applied and Computational Statistics Group	
NIST Research Advisor:	Mary Gregg	
Title of Talk:	Improving encoding algorithms for GC-MS analysis in forensic fire debris research	

Abstract:

In arson investigations, debris recovered from structural fires requires samples to be extracted and analyzed to determine the presence/absence of ignitable liquids. A new extraction method, dynamic vapor microextraction (DVME), was recently developed and needed to be optimized. DVME extracts vapor from the headspace of debris and analyzes the collected sample through gas chromatography-mass spectrometry (GC-MS). To optimize DVME performance, a fractional factorial experiment was conducted to determine the effect of various instrument settings (e.g., oven temperature; type of sorbent coating) on the recovery of ignitable liquid. Experimental results were assessed by quantifying the similarity between reference samples and the captured headspace from experimental runs.

GC-MS produces chromatographic data, which records ion abundance as a function of time. Ignitable liquids are complex mixtures whose chromatographic profiles are composed of many ions spanning various chemical classes. Analysis of the experimental data requires quantifying similarity between such chromatographic data obtained under experimental conditions to chromatographic data of neat ignitable liquids, but the effects from experimental factors may not be uniform across ions of different classes. As such, different methods of quantifying similarity may result in different experimental conclusions.

This project assessed five metrics that could be used to analyze the collected experimental data. These metrics included a comparison based on covariance mapping, a metric derived from correlation coefficients, and three metrics that rely on principle component analysis. Three of these metrics are established in the chemical literature while two are newly considered. Data preprocessing methods, such as normalizing and scaling, were also considered. The culmination of this project is a recommendation on optimal analysis methods for the experimental chromatographic data collected by DVME.



SURF Student Colloquium

NIST – Boulder, CO
August 13-15, 2024

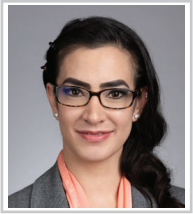
Name: Conor Wellman		
Academic Institution:	Colorado College	**Major:** Mathematics, Computer Science
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Graduate School, Software Engineering	
NIST Laboratory, Division, and Group:	PML - Time and Frequency	
NIST Research Advisor:	Judah Levine	
Title of Talk:	Internet Clock Synchronization Algorithms using Clock Statistics	

Abstract:

Clock accuracy is crucial for operation in many fields, including sciences, the stock market, and communications. While agencies such as NIST operate and broadcast the UTC time scale from an ensemble of atomic clocks, synchronization algorithms are required to keep clocks around the world accurate to this standard with a high level of precision.

Due to jitter in the time difference data collected from querying time servers, several statistical methods must be used to ensure accurate synchronizaiton. Methods such as the Allan Variance and Time Deviation can be used to determine optimal synchronization intervals, while other methods such as Kalman Filters can be used to detect noise at non-optimal intervals. By employing these methods and more, it is possible to design algorithms to keep client clocks synchronized to the UTC time scale with a high degree of accuracy over the internet.

This project demonstrates possible synchronization algorithms while discussing results from tests of these algorithms on NIST time servers.



SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name: Michelle Crouse		
Academic Institution:	California State University, Dominguez Hills	**Major:** Biochemistry
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Ph.D. in Pharmaceutical Sciences | Drug Discovery, Development, and Delivery Research	
NIST Laboratory, Division, and Group:	Communications Technology Laboratory, RF Technology Div, Guided Wave Electromagnetics Group	
NIST Research Advisor:	Robert Lirette	
Title of Talk:	Developing Acoustic Absorption Metrology in Liquids	

Abstract:

Acoustic absorption spectroscopy can probe intermolecular interactions that inform optimized processes and products for chemical manufacturing and pharmaceutical industries. For many relevant chemicals, these interactions occur at ultrasonic frequencies and extend down to the kilohertz. The only commercial acoustic spectrometer covers a frequency range of 3 MHz to 100 MHz, missing many essential absorption mechanisms at lower frequencies. To fill this frequency gap, I employed the variable path through-transmission method to build a low-frequency acoustic spectrometer that covers the 600 kHz to 6 MHz bandwidth. I used thirty-one amplitude measurements at varying distances. These multiple measurements significantly improved measurement accuracy when compared to conventional through-transmission and pulse-echo techniques that rely on only two measurements. I measured pure water to correct the data for diffraction effects and used repeated measurements of water to propagate the uncertainty. To validate the spectrometer, I measured salt solutions and a series of polyvinyl alcohols of various molecular weights and compared the results against those obtained from a commercial acoustic spectrometer. The salt solutions included zinc chloride, magnesium sulfate, and scandium sulfate. Notably, I observed a relaxation peak near 1 MHz in scandium sulfate, which was only reported once before with the use of a resonator method. The data and analysis presented here serves as a foundation for developing acoustic absorption spectroscopy as a robust tool for chemical analysis in various industries.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Katherine Ellis
Academic Institution:	University of Michigan
Major:	Chemical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate school for a PhD in Chemical Engineering
NIST Laboratory, Division, and Group:	PML, Quantum Sensors Division, Quantum Calorimeters
NIST Research Advisor:	Nathan Nakamura and Daniel Swetz
Title of Talk:	Monte Carlo Modeling for Nanoscale X-ray Tomography of Nanoelectronics

Abstract:

X-ray computed tomography (CT) is a powerful method for the inspection of integrated circuits, providing 3D images of the internal structure. The interior of an integrated circuit (IC) is difficult to examine after manufacturing due to the multiple material compositions, and a high number of close packed nanoscale features in the chip area. Accurate imaging and measurement of this complex internal structure provides important data for manufacturers to study the defects, structural properties, and manufacturing fidelity within ICs. 3D metrology of buried IC features requires the ability to image features from the micrometer to the nanometer-scale, with sensitivity to feature shape, size, and elemental composition over planar chip-scale areas. No current approach to x-ray CT fulfills these requirements, creating a critical measurement gap in the semiconductor ecosystem. The Quantum Calorimeters Group at NIST has developed a prototype nano-CT instrument and demonstrated 3D imaging of integrated circuits with 160 nm spatial resolution. Modern ICs contain elements that span in size from hundreds of micrometers to sub-ten nanometers, as such it is desirous that the instrument have a special resolution small enough to identify even the nanometer scale elements. Pushing the capabilities of the nano-CT instrument will allow NIST to fulfill the high impact measurement gap in the semiconductor industry leading to improvements in the fabrication and quality of IC technology.

To push the capabilities of this instrument further, electron-photon transport modeling is required to better understand the relevant physics underlying the system operation and guide future system design for tomographic data collection. Utilizing TOPAS (Tool for Particle Simulation) such a model has been created in two parts. The first part of the model studies the process of x-ray generation within the instrument and is the first step towards a full system model. The nano-CT instrument utilizes an electron beam incident on a thin film metal target, generating a nanoscale x-ray source inside the metal layer. The generation volume of the characteristic and bremsstrahlung x-rays within the target sets the x-ray source spot size, which is a critical parameter influencing the spatial resolution of the system. In addition, properties of the metal target and incident electron beam can be modeled and studied for their influence of the geometric magnification and contrast in the sample which define the capabilities of the instrument to accurately image the IC. This first part of the model has been extensively tested and compared with experimental data to validate the model setup and confirm that the appropriate physics models were used to setup simulations. The second part of the model is focused on the detector itself. There are existing data analysis algorithms that artificially add the detector response to a set of generated data. However, adding the detector directly into the simulation serves as the next step towards a full system model that can generate synthetic tomography data of a given IC design. In the future, both aspects of this model can be expanded on in order to study the optimization of spatial resolution and image generating algorithms for instrument. Further, the model can be used to quickly study a wide variety of experimental setups, saving crucial time and resources used in physical experiments.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Gabriella Erich		
Academic Institution:	University of Colorado Boulder	**Major:**	Biomedical Engineering
Academic Standing (Sept. 2024):	Undergraduate Degree Senior (Final semester)		
Future Plans (School/Career):	Work in biomedical engineering industry and attend a graduate school for biomedical engineering		
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Applied Physics Division, Magnetic Imaging Group		
NIST Research Advisor:	Samuel Oberdick		
Title of Talk:	Development of magnetic nanoparticles for low-field magnetic resonance imaging		

Abstract:

Magnetic resonance imaging (MRI) is a non-invasive and radiation-free way to produce three-dimensional images of soft tissue within the body. Traditional MRI is performed at magnetic field strengths of 1.5 T to 3 T. Generation of tesla-scale magnetic fields requires large scanners with high power requirements and additional infrastructure. Recently, MRI scanners that operate at lower fields have been developed. Low-field MRI (LF-MRI) scanners require significantly less power and space for operation. LF-MRI scanners can be portable, enabling use in intensive care units since scanners can be wheeled directly to patients. There are also opportunities to use LF-MRI in under-developed communities in the world, which lack the infrastructure needed for traditional MRI systems. Contrast agents (CAs) are used to enhance the contrast of structures with MRI and are used regularly at clinical field strengths. However, it is yet to be understood what defines a good contrast agent for LF-MRI.

In this study, we characterize CAs using an FDA-approved LF-MRI system that operates at 64 mT. Recent work at NIST showed that iron oxide magnetic nanoparticles (MNPs) have the capacity to perform well as CAs at 64 mT. Additional research is needed to better understand how the structural and magnetic properties of the MNPs affect LF-MRI contrast. To evaluate the CAs performance, we measured their relaxivity, which indicates how well the agent causes proton relaxation as a function of concentration unit of the CA. We investigated the effect of particle size, surface coating, magnetization, and the diffusivity of surrounding water molecules on the relaxivity of various CAs.

SURF Student Colloquium

NIST – Boulder, CO

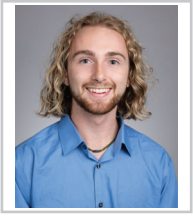
August 13-15, 2024

Name: Robert Harper		
Academic Institution:	Centre College	**Major:** Physics and Chinese
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Current plan is to attend graduate school to pursue a Ph.D. in Physics.	
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Quantum Sensors Division, Quantum Calorimeters Group (687.12)	
NIST Research Advisor:	Paul Szypryt	
Title of Talk:	TKID Simulations Using Geant4 and G4CMP	

Abstract:

Thermal kinetic inductance detectors (TKIDs) are new cryogenic superconducting resonator devices that are being developed for the detection of charged particles and gamma-rays. Currently, these devices are being used for experiments in quantum information science and will eventually be used for nuclear physics research at the NIST Center for Neutron Research (NCNR). TKIDs use a large absorber which enables detection of highly energetic events. The deposited energy from a photon/particle heats up the island which breaks Cooper pairs in the superconducting film on the device causing quasiparticles to be produced. These free quasiparticles increase the kinetic inductance of the device causing a shift in the resonant frequency. This shift in resonant frequency can then be read out with standard microwave techniques to determine the energy of the deposited photon/particle. Despite already being experimentally implemented, the underlying physics such as the phonon transport mechanisms that result from energy deposition are not entirely understood. One potential issue is that device performance could be constrained by the exact arrival location of a photon/particle within the detector.

In an effort to understand the athermal phonon transport as a function of position in these devices, we model the TKID in a particle simulation toolkit software called Geant4. To implement the phonon physics processes required for these simulations, we use the Geant4 Condensed Matter Physics package (G4CMP). Our goal is to model the TKID in Geant4 and utilize the G4CMP software to test various aspects of the device such as the position dependence and energy loss through the legs. As we simultaneously test the device in the laboratory, the experimental data will be compared with the simulation data to characterize the detector's response and better understand TKID physics. The info that we acquire from the G4CMP simulations will allow for improved TKID geometric design to optimize device performance and allow for us to account for any positional dependence that we observe.



SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name: Eric Johnson		
Academic Institution:	The College of Wooster	**Major:** Physics
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Graduate School in Medical Physics	
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Applied Physics Division, Medical Imaging Group	
NIST Research Advisor:	Stephen Russek	
Title of Talk:	Development of radiation sensitive gels for MRI based 3D dosimetry	

Abstract:

Radiation therapy is one of the most common treatments of cancer that sends high energy X-rays (~5 MeV) to kill cancer cells. Gel dosimeters are used to measure the amount of radiation applied and its distribution to ensure a lethal dose is applied to the cancerous tissue, while sparing surrounding health tissue. In this research, we are developing novel MRI-readable gel dosimeters that can image X-ray dose in 3D in biomimetic phantoms. Fricke gel and polymer gel dosimeters were tested. In the Fricke gel dosimeters, ferrous ions transform to ferric ions when irradiated, absorption spectroscopy can measure the concentration of ferric ions. In polymer gel dosimeters, monomers polymerize when exposed to radiation. The dosimeters were exposed to x-rays from a microCT. Quantitative MRI was used before and after irradiation to measure/image changes in the spin relaxation times T1, T2, and water diffusion constant D. Changes to these values means the dosimeter is radiation sensitive and is therefore a good dosimeter. Fricke solutions have shown to be slightly radiation sensitive while polymer gels have shown to be radiation sensitive. In addition to being able to correlate changes in T1, T2, and D to X-ray dose, these measurements give information on how the materials are changing in response to radiation. Measuring other radiation effects, in addition to measuring dose, will be critical to fully understand and personalize radiation treatment in the future.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Vallabh Kudva
Academic Institution:	University of Texas at Dallas
Major:	Mathematics and Statistics
Academic Standing (Sept. 2024):	Senior to graduate in December 2024
Future Plans (School/Career):	Graduate school
NIST Laboratory, Division, and Group:	Information Technology Laboratory (ITL); Statistical Engineering Division (Division 776); Applied and Computational Statistics
NIST Research Advisor:	Caitlin M. Berry and Amanda A. Koepke

Title of Talk: Method Development and Best Practices for Atomic Clock Metrology

Abstract:

Current atomic clocks have 16-digit accuracy, with the second defined as 9,192,631,770 Hz of the cesium-133 atom. Optical atomic clocks have the potential to redefine the second, and have more than 18-digit accuracy. But these optical atomic clocks have significant downtime, resulting in gaps in the data that can stretch or violate the assumptions of current statistical models.

The spectrum of the optical atomic clock data is the distribution of the frequency components. Clock scientists want to look at the spectrum and understand the noise processes that affect it. They analyze plots of the time domain Allan variance (AVAR), a measure of frequency stability. They also want a better way to deal with the gappy clock data with fewer assumptions about the noise processes. The main goal of this research is to use exploratory data analysis (EDA) to investigate a multitaper spectral estimate (MTSE) of data with gaps.

The periodogram is an estimate of the spectral density of a signal, but this is a biased estimate because it fails to deal with spectral leakage. A better estimate of the spectrum is the multitaper spectral estimate (MTSE), which averages multiple independent sinusoidal tapers to estimate the spectral density of a signal to deal with spectral leakage. The integral of the product of the transfer function and MTSE is equal to the Allan variance. Previous work developed a MTSE that works for data with gaps to use in calculating AVAR; we extend this work to include EDA of the spectrum.

EDA uses descriptive statistics and statistical graphics to visualize and analyze data. We will use linear regression and other modeling techniques to understand trends in the spectral estimate. We demonstrate our techniques on both real and simulated data for this research. By using EDA and the MTSE to visualize and understand the spectrum for data with gaps, we can provide clock scientists with new tools for analyzing the frequency stability of these optical atomic clock oscillators.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Bianca Meurer-Zeman	
Academic Institution:	University of Colorado, Boulder	**Major:** Neuroscience
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Graduate School for biomedical engineering	
NIST Laboratory, Division, and Group:	Magnetic Imaging Group, Applied Physics division, Physical Measurement Lab	
NIST Research Advisor:	Mark Ferris and Gary Zabow	
Title of Talk:	Optimization of Magnetic SMART Hydrogel Sensor for Increased Sensitivity	

Abstract:

Whether it be testing for environmental contaminants in murky water or monitoring diabetes in a non-invasive way using saliva rather than blood, there is a need for more accessible sensors for personal use. High-sensitivity measurements are particularly challenging, and the current laboratory equipment required for these measurements is expensive and inconvenient. An accessible magnetic sensing platform with high sensitivity was recently introduced by utilizing a smartphone magnetometer and a magnetic hydrogel structure that curls and displaces magnetic particles in response to the target analyte concentration, with the displacement of magnetic particles measured via a change in field strength recorded by the magnetometer. However, due to the cubic decay of magnetic fields in space, a large amount of sensitivity is lost with the magnetometer being buried deep within the phone. In this work, we replace the smartphone with an Arduino-based magnetometer such that the magnetic hydrogel structure can be placed directly on the magnetometer. With the smartphone interface, single-digit micromolar glucose detection was achieved. However, with an increase in sensitivity, the Arduino interface should be able to detect nanomolar range glucose concentrations. We expect that these highly sensitive portable measurements will be able to rival expensive laboratory equipment and even be more advantageous due to its accessibility.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Zachary (Zach) Miles
Academic Institution:	Purdue University
Major:	Applied Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	PhD in Quantum Engineering, career in the quantum industry or academia
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Quantum Sensors Division, Quantum Electronics Group
NIST Research Advisor:	Corey Rae McRae
Title of Talk:	Development of a Superconducting Microwave Resonator Open-source Codebase

Abstract:

Superconducting circuits are one of the leading realizations of quantum bits (qubits) towards quantum computation. A common method of measurement of such qubits is via the superconducting resonator. Accurate and precise measurement and analysis of superconducting resonators is vital to accurately gain information about decoherence sources limiting today's qubit performance. Conducted in a survey, it was found that different labs in the field yielded widely different data analysis results. This project addresses the need for a standardized data analysis package when measuring superconducting resonators for any application in the field. The Boulder Cryogenic Quantum Testbed hosts the Python package "scresonators", an open-source codebase for researchers measuring superconducting resonators. scresonators will allow researchers to provide their existing data and compare the results of a standardized fitting package with their own fitting methods. This project adds new features including plotting functionality to scresonator's most recent refactored, modularized version. These tools can easily plot experimental data at different points in the data analysis. Testing code was implemented in Jupyter notebooks through different experimental datasets. scresonators is still a work in progress, but moving forward, the package will continue to be open-source, made for the community, by the community.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Benjamin O. Nienhouse
Academic Institution:	University of Colorado Boulder
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Automotive Engineering
NIST Laboratory, Division, and Group:	PML, Applied Physics Division, Sources and Detectors
NIST Research Advisor:	Kyle Rogers
Title of Talk:	Adaptable HALO design for high power laser calibrations

Abstract:

The HALO (High Amplification Laser-Pressure Optic) is a device designed by NIST to measure laser power using the radiation pressure of a laser beam incident off a highly reflective "sensing" mirror. My project is to revise the HALO with three distinct goals: to reduce power uncertainty to less than 1.0 % for a NIST calibration standard, to implement portability and application with various precision measurement force balances, and to decrease the device's size. The current HALO's size is roughly that of a refrigerator which will be reduced to a portable instrument roughly the size of a shoe box, decreasing the calibration time from weeks to just a matter of days.

Currently, the HALO design consists of a ring of 14 highly reflective "ring" mirrors above a sensing mirror at the center with an incoming laser beam that "bounces" between the ring and sensing mirrors forming a conical shape, all within a laser safe enclosure. To mathematically calculate the laser power, the angle of each beam incident on the sensing mirror must be well-known. The current HALO design uses a 45-degree angle of incidence (AOI), making it very difficult to align with low angular uncertainty. Making the design smaller allows us to decrease the AOI, which in turn decreases its effect on the power variance, making it possible to attain the goal expanded uncertainty of 0.5 - 1.0 % (k=2). NIST has developed devices to measure laser power above 1,000 watts and below 10 watts, and my design aims to bridge between these points to realize this measurement gap.

SURF Student Colloquium

NIST – Boulder, CO
August 13-15, 2024

Name: Lincoln Queale

Academic Institution: Mount St. Mary's University | **Major:** Mathematics

Academic Standing (Sept. 2024): Senior

Future Plans (School/Career): Grad School, Teaching/Research

NIST Laboratory, Division, and Group: Information Technology Lab, Statistical Engineering Division, Applied and Computational Statistics

NIST Research Advisor: Lucas Koepke, David Newton

Title of Talk: Statistical Modeling of High-Cycle Metal Fatigue Data

Abstract:

Metals produced via additive manufacturing are being increasingly used in critical roles where their function or failure can have life or death consequences. Data collection for the life cycles of these metals is limited by time constraints, resulting in censored data. The censored non-linear nature of the data makes for a unique analysis and modeling challenge. Various models exist in the literature for this problem, but most fail to provide results with the statistical properties needed for critical usage.

The objective of this project was to quantitatively evaluate and compare the effectiveness of several models for stress-life cycle data , and to explore ways of improving existing models. Given the limited availability of real data, simulated data was used in addition to data from experiments carried out at NIST. This required the development of effective simulated data generators. This was done with both Gaussian distribution and Generalized Extreme Value distributions that incorporate skew . We incorporated inference techniques such as maximum likelihood estimation and Bayesian inference to find optimal parameters for model fitting for our chosen models. The resulting fits were then numerically evaluated to determine the best fitting model, and suggestions will be made for next steps for further improvements.

SURF Student Colloquium

NIST – Boulder, CO
August 13-15, 2024

Name: Ryan Mapes			
Academic Institution:	Colorado School of Mines	**Major:**	Computational Applied Mathematics
Academic Standing (Sept. 2024):	Senior and Master's Student		
Future Plans (School/Career):	PhD		
NIST Laboratory, Division, and Group:	Statistical Engineering Division		
NIST Research Advisor:	Lucas Koepke		

Title of Talk: Ask the Magic Conch: Using Machine Learning to Improve Statistical Estimator Accuracy

Abstract:

Making decisions about which statistical method to use among two or more competing options is often guided by general recommendations, without specific knowledge about a given data set. Different statistical estimators (functions of the observed data that produce parameter estimates) can target the same parameter of interest, but work best for different data sets or assumptions. Simple regression is a common statistical problem targeting estimates for the slope and intercept of a line, and we explored using a machine learning classifier to choose the best method for us. Common methods like least squares are the default approach to fit a line to data, but assume Gaussian noise. When the noise distribution is heavy-tailed, for example a t-distribution, robust regression can give us better estimates. However, in many situations it is highly ambiguous what estimator will give us the most accurate results. Especially in the case of low sample size (N=10 data points) and t-distributed errors, it is nearly an even split on whether LS or robust regression is the best choice.

We implemented and investigated a machine learning oracle designed to choose the best slope estimate from two candidate estimators by training on fully synthetic data generated from a range of slopes near the initial slope estimate. Initial results showed a roughly 80% accuracy was possible in choosing the better of the two slope estimators. With clever debugging and machine learning optimization techniques, we were able to improve the accuracy of the prediction by almost 10%. Furthermore, we investigated new potential applications of this technology, including multivariate regression and choosing the optimum cutoff value in the Huber loss function. We also explore the feasibility of extending these ideas beyond statistical estimators to more general formats, which could allow oracles to improve other decision problems like function optimization and sorting algorithm selection.

SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name:	Elliot Topper
Academic Institution:	The College of New Jersey
Major:	Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a career in Software Engineering or Web Development
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Statistical Engineering Division
NIST Research Advisor:	David Newton, Julia Sharp
Title of Talk:	LOD Calculator: A Web Application to Compute Limits of Detection

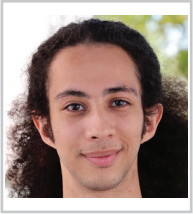
Abstract:

Limits of Detection (LODs) are used to describe the limitations of analytical measurement tools. In microbiology, an LOD seeks to characterize the minimum number of Colony-Forming Units (CFUs) that can be detected for a given measurement approach. However, there is no universally accepted way to calculate LOD in microbial samples. Sharp, Parker, and Hamilton (2023) propose a method which incorporates extra-Poisson variability to model LOD.

Although this approach has important implications for microbiologists, there may be some barriers to incorporating these methods in practice. This project explores the development of a web application which implements the methodology proposed by Sharp, et al. (2023) into a user-friendly interface. To integrate the core requirements of usability, accessibility, and performance, the LOD Calculator application utilizes dynamic front-end manipulation of graphs to model parameter-specified extra-Poisson distributions. Additionally, the application supports the use of the model to calculate discrete LOD values given a number of user-specified parameter values. The resulting application can be used by researchers nationwide for further understanding and application of LOD in microbiology.

In this presentation, a combination of demonstration of use and presentation of features and functionality will be used to present both LOD Calculator and other web applications explored during the program.

Sharp, J. L., Parker, A. E., & Hamilton, M. A. (2023). Calculating the limit of detection for a dilution series. Journal of microbiological methods, 208, 106723. https://doi.org/10.1016/j.mimet.2023.106723



SURF Student Colloquium

NIST – Boulder, CO

August 13-15, 2024

Name: Gregory Wickham

Academic Institution: Harvey Mudd College **Major:** Math and Computer Science

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career): Math PhD

NIST Laboratory, Division, and Group: ITL, Statistical Engineering Division, Applied and Computational Statistics Group

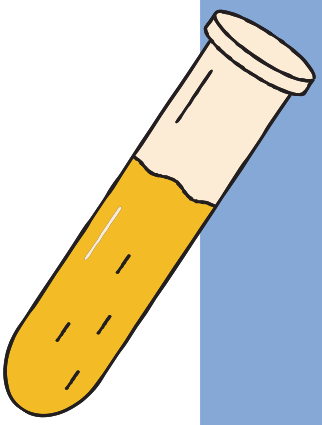
NIST Research Advisor: Michael Frey

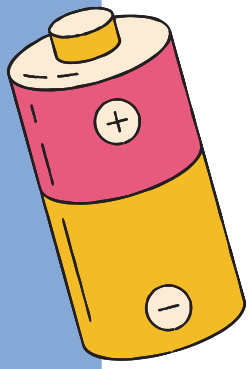
Title of Talk: Estimating ROC Curves Assuming Multiplicative Noise that is Generalized Gamma Distributed

Abstract:

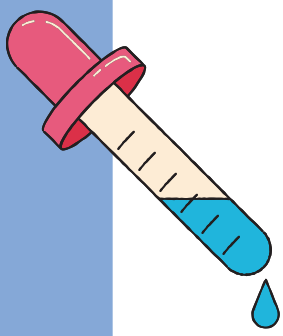
Signal detector performance is limited by the presence of background noise. A receiver operating characteristic (ROC) curve shows the tradeoffs a detector makes between the probability of correctly detecting a signal and the probability of falsely detecting a signal when none is present. Detector background noise is multiplicative in many settings including radar and sonar detection and problems involving multipath propagation. Multiplicative noise is often well-modeled by a generalized gamma (GG) distribution. This means that the detector statistic with no signal is GG-distributed with a particular scale parameter, and that the detector with a signal present has the same GG distribution but with a different scale parameter. Importantly, the two GG distributions have the same shape parameters.

This project's purpose is to develop a method based on maximum likelihood (ML) to estimate the parameters of the detector statistic GG distributions that result from multiplicative GG noise. This allows a smooth, concave ROC curve and uncertainty regions on the curve and the parameter estimates to be constructed. Without this method, a staircase ROC curve estimate is usually constructed directly from collected data. This curve estimate is difficult to use and makes uncertainty estimation problematic. For GG multiplicative noise the ROC curve can be expressed in closed form in terms of our ML parameter estimators. This allows the ML estimation uncertainty to be propagated to the ROC curve itself. We evaluate this and other methods of constructing ROC curve uncertainty bands.





NIST | COMMUNICATIONS TECHNOLOGY LABORATORY



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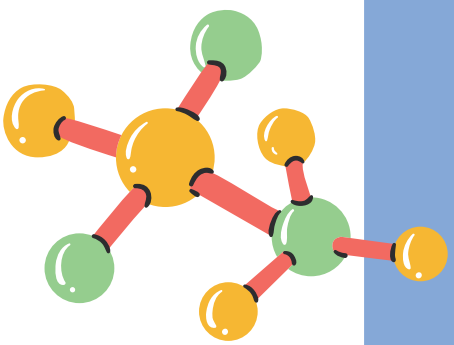
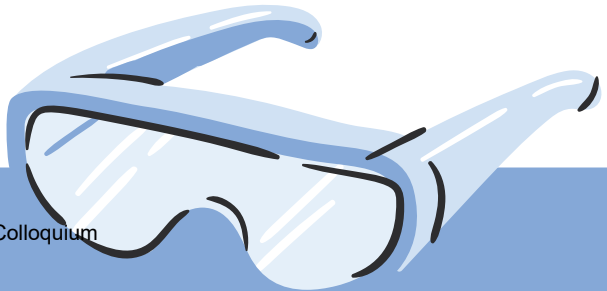




Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Communications Technology Laboratory (CTL)

Nathan Wei - **CTL plenary speaker**	Supporting UDP Communications for a Real-Time Control Robotic Application
Themla Caplan	Establishing Zero Trust in O-RAN
Niolas Carbone	Collecting and Analyzing Data from a Manufacturing Testbed
Nihar Kapasi	Simulation and Modeling of Future Wireless Communication Systems
Andrew Oxenberg	File Isolation and Dependency Mapping for STEP Standards in EasyEXPRESS
Kevin Song	Developing a Graphical Data Analysis Tool for SimPROCESD
Benjamin Winig	Creating Data Management Foundations for a Simulated Manufacturing Environment
Tyler Wong	Software Development for Internet of Things (IoT) Device Interoperability Analysis
Howard Dai	ML-Based Multipath Component Extraction and False Detection Recognition

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Nicolas Carbone

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2024): Sophomore

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

NIST Laboratory, Division, and Group: CTL, Smart Connected Systems Division/Smart Connected Manufacturing Systems Group

NIST Research Advisor: Dr. Michael Sharp

Title of Talk: Collecting and Analyzing Data from a Manufacturing Testbed

Abstract:

Implementing an AI driven monitoring system for any Industrial Manufacturing process requires a multitude of heterogeneous data sources including physical sensors, product quality cameras, system and control logs, user logs, and automated monitoring outputs. When considering operator input it is crucial to understand the reliability of an operator in detecting anomalies in the system as well as understanding how their perception of the system differs from the established physical sensor values. Operator input can be integrated into an implementation of an AI driven monitoring system by utilizing Technical Language Processing to transform textual input into a data source that can be introduced into the monitoring system. Handling these data sources in a proper manner requires documenting the data sources creation process, storage locations, exfiltration methods, as well as any analysis or manipulation done on the data sources.

My work within this project focuses on the data generated by the CROW workstation. I have worked on creating a pipeline for exporting and storing data generated by workstation experiments along with writing documentation for the data, describing the methods by which it was generated down to the structure of the raw data. My work also focused on generating a new data source by having subjects of varying experience with the CROW workstation view experiments and provide their observations of how the workstation performed. The final portion of my project focused on validating and normalizing the generated data in preparation for further analysis by myself and the team in the future.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

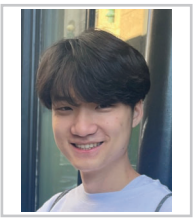
Name: Thelma Caplan	
Academic Institution: University of Maryland, Baltimore County	**Major:** Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a master's in computer science
NIST Laboratory, Division, and Group:	Communications Technology Laboratory, Wireless Networks Division, Internet Technologies Research Group
NIST Research Advisor:	Oliver Borchert, Scott Rose
Title of Talk:	Establishing Zero Trust in O-RAN

Abstract:

The Radio Access Network (RAN) is the segment of 5G mobile networks responsible for connecting user devices to a network via radio signals. It contains multiple software components used to carry out this functionality. Open RAN (O-RAN) is an open-source implementation of RAN and contains specifications for how these different components should work together. O-RAN components are deployed dynamically via Kubernetes. This means that operators do not need to monitor and re-deploy systems as they go down but can instead configure the desired state of each service. Then, when a component fails, it will be automatically recreated. While this makes the RAN easier to maintain and less prone to outages, workloads within this system do not have stable identities, making it difficult for them to authenticate each other before establishing communication.

The goal of this project is to create a proof-of-concept for establishing zero trust within an O-RAN deployment. Zero trust is the cybersecurity principle that all components must be authenticated before they can access resources from other components in the network. This is an important feature as it ensures the security of data between communicating parties and prevents man-in-the-middle attacks.

To achieve this, the project uses the Secure Production Identity Framework for Everyone (SPIFFE), which is a framework that assigns identities to workloads based on their individual traits. Istio, a service mesh, is then used to dynamically fetch these identities for its assigned workloads, establishing a mutual secure connection via mutual Transport Layer Security (mTLS) between them even as individual instances of the workloads fail and are recreated.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Howard Dai
Academic Institution:	Yale University
Major:	Computer Science
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	PhD in CS or math, then career in research or academia
NIST Laboratory, Division, and Group:	CTL ,Wireless Networks Division (673), Radio Access and Propagation Metrology Group
NIST Research Advisor:	Jack Chuang and Jian Wang
Title of Talk:	ML-Based Multipath Component Extraction and False Detection Recognition

Abstract:

When wireless signals travel from a transmitter to a receiver, such as from a cell tower to a handheld device, they reflect and scatter off objects in the environment to produce numerous copies that arrive at the receiver at different times and from various angles. Because these signals take multiple paths from the transmitter to the receiver, they are known as Multipath Components (MPCs). MPCs used to be a problem for communications engineers because they tend to interfere with each other at the receiver. However, technologies developed over the past few decades, such as using multiple antennas to recombine MPCs constructively, have allowed wireless networks to achieve increasingly fast data rates. The next generation of wireless networks will incorporate advanced wireless channel modeling between the transmitter and receiver. It will support joint communications and sensing (JCAS), where the data signals will also give the devices information about the location and movement of nearby objects like people and vehicles. Extracting MPCs and classifying them is an essential function that will make these new features possible. Currently, NIST uses the CLEAN-Space-Alternating Generalized Expectation (CLEAN-SAGE) algorithm, which can suffer performance degradation and false detection events due to a mismatch between the theoretical and actual received signals.

This talk discusses two proposed solutions, both relying on machine learning: a classification model for false signal detection and a regression model for direct MPC extraction. The classification model uses a convolutional neural network (CNN) to predict truth values for proposed signals, which can be used alongside CLEAN-SAGE to reduce false detections. The regression model uses a larger CNN and several fully connected linear layers to directly predict the (range, azimuth angle) coordinates of one or more MPCs. We will discuss how we trained both models and show they achieve high accuracy on simulated and real-world data.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Nihar Kapasi
Academic Institution:	University of Massachusetts Amherst **Major:** Computer Science and Mathematics (BS)
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Enter the industry/Proceed to graduate school
NIST Laboratory, Division, and Group:	Wireless Networks Division - Communications Technology Laboratory
NIST Research Advisor:	Wesley Garey
Title of Talk:	Simulation and Modeling of Future Wireless Communication Systems

Abstract:

Mobile networks are constantly evolving to the meet the ever-increasing demands of mobile network users - from First Generation (1G) networks that only supported voice, to Fifth Generation (5G) networks that support voice and data with ultra-reliable low latency, massive machine-type connectivity, and data rates of up to 20 Gbits/s. To support this evolution, network simulators such as ns-3 are used to understand the behavior and applicability of features through system-level modeling and simulation of these networks. Insights obtained from these simulations can be used to provide configuration guidelines to network operators, optimize performance, and identify pitfalls that need to be addressed in future versions.

This talk will provide an overview of how ns-3 simulations are used to study various aspects of mobile networks with respect to public safety communication. With the help of example scenarios, it shall demonstrate the capabilities of ns3. It shall cover the data that can be extracted from such simulations as well as the visualization companion of ns-3 – the NetSimulyzer and how it is used to visualize simulations.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Andrew Oxenberg		
Academic Institution: University of Maryland, College Park	**Major:** Computer Science	
Academic Standing (Sept. 2024):	Sophomore	
Future Plans (School/Career):	Software Developer	
NIST Laboratory, Division, and Group:	Communications Technology Labratory (CTL)	
NIST Research Advisor:	Allison Barnard Feeney	
Title of Talk:	File Isolation and Dependency Mapping for STEP Standards in EasyEXPRESS	

Abstract:

STEP (STandard for the Exchange of Product Data) is a neutral file format used to transfer digital product data (e.g., design, manufacturing,...) between systems (e.g., CAD, CAM, PLM,...).

STEP structure is defined using EXPRESS, an information modeling language, in the form of EXPRESS schemes. A significant problem faced by STEP developers is navigating its large codebase (i.e., over 1 GB of data) when only a few specific files are needed at a time. To address this, my project focuses on: 1) simplifying the representation and navigation of large EXPRESS codebases, and 2) providing additional visual information such as dependencies between the different EXPRESS schemes.

I developed a new Visual Studio Code extension (STEP-Explorer) to add these 2 features to an existing extension (NIST's easyEXPRESS) that implements language support for EXPRESS.

SURF Student Colloquium

NIST – Gaithersburg, MD August 13-15, 2024

Name: Kevin Song	
Academic Institution: Vanderbilt University	**Major:** Computer Science
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Software Engineer
NIST Laboratory, Division, and Group:	Communications Technology Laboratory, Smart Connected Systems Division, Smart Connected Manufacturing Systems Group
NIST Research Advisor:	Dr. Michael Sharp
Title of Talk:	Developing a Graphical Data Analysis Tool for SimPROCESD

Abstract:

Understanding production processes and maintenance policies is key for production planning, especially as the manufacturing industry increasingly integrates its assets with Internet of Things (IoT) technologies and Industrial Artificial Intelligence (IAI) tools. As such, accurately analyzing and testing manufacturing systems before implementation is essential. SimPROCESD, an open-source software developed by NIST, provides users with the tools to rapidly build and test models of discrete manufacturing systems. This simulator enables users to evaluate automated systems thoroughly in various environments and situations. Designed to be modular and customizable, users can readily edit SimPROCESD code to support their manufacturing use cases and end goals.

Users interact with SimPROCESD through Python terminals and commands to create the desired simulation environment, and recently, development on a graphical user interface for SimPROCESD has been initiated. My summer project in the NIST SURF program focuses on developing a user-friendly graphical interface for a data analysis feature. Through my data analysis feature, users can select and view raw data streams that reflect production processes. Examples include part quality, part value, buffer level, and resource amount. Users can also view processed data streams that typically reflect key performance metrics relevant to production, which include cycle time, throughput, inventory, and production costs. With these data streams, users can conduct data and statistical analysis to evaluate performance of each device and/or the system as a whole. Overall, the data analysis feature facilitates the data visualization use case of SimPROCESD, which helps reduce time for statistical calculations and allow users to interact and better understand their production processes.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Nathan Wei
Academic Institution:	University of California, Los Angeles
Major:	Computer Science
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	I plan to attend graduate school
NIST Laboratory, Division, and Group:	Communications Technology Lab, Smart Connected Systems, Networked Control Systems Group
NIST Research Advisor:	Karl Montgomery
Title of Talk:	Supporting UDP Communications for a Real-Time Control Robotic Application

Abstract:

Wireless communications are expanding into industrial communications systems. Traditionally wired communications are used for mission critical systems; however, reliability and latency enhancements for wireless communications enables wired links to be "cut" in favor of the more flexible wireless communications. There is a need for industrial wireless systems to have lower latency and improved reliability to increase safety and versatility. NIST s Industrial Wireless Systems Lab has a robotic testbed that emulates a dual-lift use case involving a leader and follower robot that communicate over wireless. The follower receives positional updates at a rate of 125 Hz from the leader. Using a velocity-based controller, the follower robot tracks the path of the leader. The network performance of the real-time control application is measured by network taps to calculate the latency of the position data packets and the physical performance is measured using the Cartesian error between the two robots.

In the past, experiments involving the transmission control protocol/internet protocol (TCP/IP) communications over the Robotics Operating System (ROS) have been performed with the dual-lift testbed. To enable a more realistic communications protocol, the project is to support the user datagram protocol (UDP), which are send and forget transmissions, allowing for the simpler scheduling of traffic using wireless time-sensitive networking. However, ROS is a TCP-based framework that does not inherently support UDP traffic. A UDP server/client socket must be implemented bypassing ROS s TCP-based traffic for the robots to communicate utilizing UDP. This involves redesigning Python code for the ROS Nodes to incorporate a UDP socket for use in the real-time control system. This project will also provide insight into how UDP and TCP traffic compare in the industrial wireless testbed by measuring the network and physical performance when subject to wireless interference loads.

SURF Student Colloquium

NIST – Gaithersburg, MD
August 13-15, 2024

Name: Benjamin Winig

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career): Undecided

NIST Laboratory, Division, and Group: CTL, Smart Connected Systems Division/Smart Connected Manufacturing Systems **rou**

NIST Research Advisor: Dr. Michael Sharp

Title of Talk: Creating Data Management Foundations for a Simulated Manufacturing Environment

Abstract:

Artificial intelligence-driven, condition monitoring-enabled maintenance policies are becoming increasingly popular in manufacturing environments, especially given ongoing advances in data analytics and the expanding availability of computing power. However, industrial operators must deploy sophisticated data management practices to integrate data from machines, maintenance, and monitoring systems if they want to realize potential production and maintenance performance improvements. Tools like NIST's SimPROCESD (Simulated-Production Resource for Operations & Conditions Evaluations to Support Decision-Making) offer a simulated industrial environment that allows manufacturers to set up production and maintenance systems and evaluate different monitoring methods. However, SimPROCESD and other systems must emulate data structures accessible by humans or machines, especially as modeling maintenance and monitoring data can get quite complex.

This presentation will focus on creating data management foundations for SimPROCESD's simulated manufacturing environment. In addition to the role of data in using Industrial Artificial Intelligence and Internet of Things technologies in manufacturing environments, our work towards creating new functions and structures to organize simulation data in a human-readable form will be discussed. This presentation will also cover the insights enabled using structured data integration and governance. These insights come from our use cases, ranging from identifying software bugs in inspection and maintenance implementations to developing methods for analyzing condition monitoring data

SURF Student Colloquium

NIST – Gaithersburg, MD

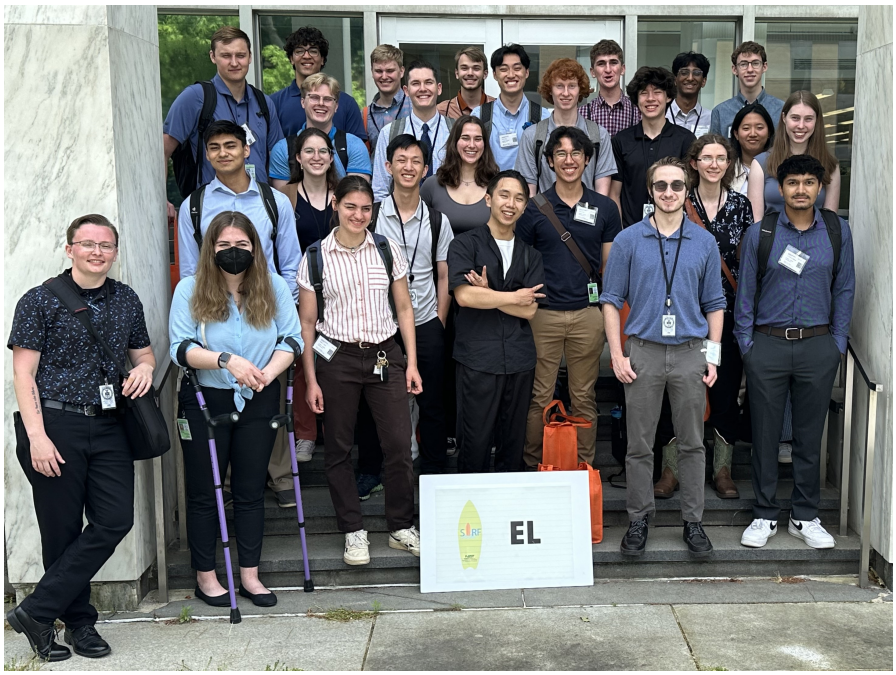
August 13-15, 2024

Name:	Tyler Wong
Academic Institution:	University of Maryland, College Park
Major:	Computer Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Computer Hardware Engineering
NIST Laboratory, Division, and Group:	Communications Technology Laboratory (CTL), Smart Connected Systems Division, IoT Devices and Infrastructures Group
NIST Research Advisor:	Dr. Eugene Song
Title of Talk:	Software Development for Internet of Things (IoT) Device Interoperability Analysis

Abstract:

Intelligent Transportation Systems (ITS) rely heavily on Internet of Things (IoT) devices (e.g., sensors and embedded devices) to provide critical information for real-time monitoring and control. However, these IoT devices are most often provided by a variety of manufacturers and vendors who adopt different standard communication protocols, leading to the major challenges in interoperability that can hinder both hardware and software development. Interoperability is the ability for two or more systems to exchange information and be able to use this information based on standardized communication protocols.

My work this summer involved first creating analysis methodology to effectively evaluate interoperability between IoT devices (e.g., road-side units (RSUs) and on-board units (OBUs)) used in ITS. This then led to the development of an open-source software tool that can input network packet data recorded from testing cellular vehicle-to-everything (C-V2X) communications between RSU and OBUs, and then quantitatively and automatically assess their interoperability based on standard protocols defined by IEEE 1609.3 and SAE J2735. It considers C-V2X messages, such as wireless access in vehicular environments (WAVE) short messages (WSM), basic safety messages (BSM), signal phase and timing (SPaT), road side alerts (RSA), and traveller information messages (TIM). The tag, length, and value of each field of each message should be checked based on the standards. This software tool can be further generalized to effectively analyze interoperability between many IoT devices in ITS.



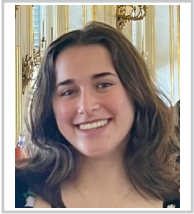
Engineering Laboratory 2024

Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Engineering Laboratory (EL)

Emma Bair - **EL plenary speaker**	Application of Standards: Designing a CMM Digital Twin
Christian Farias	Communications and Science: Illustrating Ingenuity
Juan Carlos Guana	Multi-Label Classification of Disaster Tweets using Transformer-based and Deep Learning
Anna Liu	Climate Change and Resilience Sentiments Following a Natural Event
Timothy Jacob	Insights on Emergency Communication Protocol and Standards
Julie Aleiner	Degradation Mechanisms and Failure Mode of Photovoltaic Polymeric Backsheets
James Alzona	Development of non-destructive polymer degradation measurements for photovoltaic backsheets
Varadraj Chavan	The Marine Microplastic Mayhem: Studying Plastic Degradation in Aquatic Environments
Natanel Solomonov	Verfication and Validation of Computational Models for Analyzing Future Impacts of Sea Level Rise
Sarah Lehrman	Analysis of Fiber Reinforced Polymer (FRP) Retrofitted Shear Walls with Openings
Samantha Farren	A Study of Concrete Materials using Optical Microscopy and X-ray Diffraction
Benjamin Johnsson	Effects of Sealants on Concrete Permeability
Jacqueline Stensland	Reactivity and Expansion of Iron Sulfides in Cement
Nelson Tucker	Developing a Database of Tornado Strikes on Warehouse-Type Structures
Sydney Holles	Investigating Building Performance Using CX Software
Kelsi Wood	Custom Digital Building Twins 3D Models to Graphs
Weiheng Oh	Pressure Loss in Pipe Fittings / Condensation of Two-phase Flow in Microchannels
Helen Catan	Testing and Analysis of Material Flammability through the Cone Calorimeter
Philip Huang	Operation/Automation of TGADSC and Construction of Intermediate Scale Flame Spread Apparatus
Alec Tripi	Development of the Molecular Weight Apparatus and Construction of the CAPA II
Shine Park	Measuring Soot Deposition on Surfaces Using Grayscale Image Analysis
Nihar Xavier	Using the Fire Dynamics Simulator (FDS) to Evaluate Wildfire Model Accuracy at Varying Complexities
Kyle Foster	Adapting the Bass Diffusion Model to Forecast Critical Material Demands for Clean Energy Technologies
McCarthy Devine	Developing and Practicing Standard Methods for Emergency Response Drones
Ethan Nowery	Testing Terrain Traversal, Dexterity, and Visual Acuity of Legged and Tracked Ground Robots
Eric Eng	Techniques for Recognition of Static Rotation Invariant Gestures
Terrence Pierce	Evaluating 3D Sensor performance usiong planar targets
Tiegan Powell	Investigating Shape-From-X Programs for Object Geometry Reconstruction
Beck Tappert	Bridging the Gap between Robotics Research and the Standard Industrial Robotic Work Cell



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Julie Aleiner
Academic Institution:	Columbia University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School (PhD)
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structural Systems Division, Infrastructure Materials Group
NIST Research Advisor:	Dr. Xiaohong Gu
Title of Talk:	Degradation Mechanisms and Failure Mode of Photovoltaic Polymeric Backsheets

Abstract:

Polymeric backsheets are an underrated component of photovoltaic (PV) cells, aiding with power output and longevity. Unfortunately, the fluoropolymers used in past backsheets negatively impact the environment and are expensive. For this reason, alternative polymer materials and construction processes were developed. The response of photovoltaics to environmental stress is a critical indicator of the reliability, durability, and safety of PV modules. While these systems are exposed to many environmental factors, the leading causes for backsheet degradation and cracking are UV exposure, humidity, temperature, and mechanical load. Backsheets yellow as they age and degrade. However, this does not impact electrical performance as significantly as cracks and delamination, which allow water vapor and oxygen into the module and cause corrosion of the metal and encapsulant.

In this study, three novel materials, CPC-1, CPC-2, and PC-1, were exposed to high-intensity ultraviolet light at 3-10 times the irradiance levels of the Sun and elevated temperature and humidity conditions in the 2-meter and 6-port (0.5m) SPHERE (Simulated Photodegradation via High Energy Radiant Exposure). This was done to simulate the effect environmental factors have on backsheet degradation. Additionally, two samples of the same material were stacked in the compartment to determine the impact of UV exposure. The samples were assessed for optical, chemical, and mechanical changes at a specific time period. Attenuated Total Reflection - Fourier transform Infrared (ATR-FTIR) was used to examine changes in chemical structures. Colorimetry and glossimetry were used for yellowing analysis, and the tensile test and confocal microscopy were used to monitor mechanical and morphological changes, respectively. With these experiments, the degradation and failure modes of backsheets made of CPC-1, CPC-2, and PC-1 will be better understood, leading to environmental benefits, better material selection, and greater reliability for solar cell technology.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: James Alzona

Academic Institution: Carnegie Mellon University **Major:** Chemical Engineering

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career): Pursue industry career post Chemical Engineering BSE graduation

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

NIST Research Advisor: Ashlee Aiello

Title of Talk: Development of non-destructive polymer degradation measurements for photovoltaic backsheets

Abstract:

Photovoltaic (PV) backsheets are multi-layer polymer films used on the back of PV modules to insulate the cell from dielectric currents and provide protection from environmental damage. Interactions with other backsheet layers, encapsulant, additives, or environmental stressors (e.g., UV, temperature, humidity, thermomechanical stress) can result in various heterogeneous failure mechanisms such as discoloration, delamination, and cracking, reducing module efficiency or even causing complete failure. Thus, degradation studies of these materials are essential to ensure module lifetime. Unfortunately, the majority of characterization methods used to study polymeric degradation in PV backsheets are destructive in nature and lack spatial resolution. New non-destructive, spatially resolved measurement techniques must be established to identify interfacial interactions in PV backsheets that lead to early failure. In this project we investigate the effects of environmental factors on coated polyethylene terephthalate-based PV backsheets that have recently been introduced by industry. Outdoor exposure is simulated via accelerated aging through controlled high intensity UV, temperature, and relative humidity. Confocal Raman spectroscopy is used to measure localized early failure indicators such as chemical degradation and crystallinity shifts. These results will be used to develop a deeper understanding of the failure points of these materials and their aging behavior and provide insight into material selection and future product development.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Emma Bair
Academic Institution:	University of Maryland, College Park
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	I plan to join the workforce after graduation, then possibly get a master's degree later on in my career.
NIST Laboratory, Division, and Group:	Engineering Laboratory, Systems Integration Division, Digital Twin Lab
NIST Research Advisor:	Dr. Guodong (Gordon) Shao
Title of Talk:	Application of Standards: Designing a CMM Digital Twin

Abstract:

Digital twins are currently being implemented in various fields including healthcare, energy, defense, and manufacturing. Although they can include various specialized features in different use cases, a digital twin can be generally regarded as a computerized copy of a physical object that can constantly accept and analyze data to accurately mimic its physical counterpart. ISO 23247, Digital Twin Framework for Manufacturing, defines a manufacturing digital twin as “a fit-for-purpose digital representation of an Observable Manufacturing Element (OME) with synchronization between the OME and its digital representation.” An OME is an entity that has an observable physical presence or operation in manufacturing, e.g., equipment, processes, products, or systems.

The compatibility and intersection with other cutting-edge tools, such as artificial intelligence, the Internet of Things, and extended reality, make digital twins a cornerstone of Industry 4.0. However, the rapid increase in research and implementation of digital twins has highlighted the need for standardization and interoperability. ISO 23247 and Digital Twin Consortium (DTC)’s Capability Periodic Table (CPT) standardize and streamline the digital twin development process.

In this project, ISO 23247 and CPT were applied to design a digital twin of the Mitutoyo Mach Ko-ga-me Coordinate Measuring Machine (CMM) in the digital twin Lab. The CMM Computer-Aided Design (CAD) model in STEP format has been updated and kinematics models have been developed in a simulation environment. Other standards MTConnect and Quality Information Framework have been researched and used for operational data collection and measurement data representation. The digital twin of the CMM is a descriptive digital twin that has two major simulation and monitoring capabilities:

- Motion simulation to reflect actual CMM operation
- Interpretation and display of measurement results

The standardized approach will facilitate interoperability and enable reusability for digital twin implementations.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

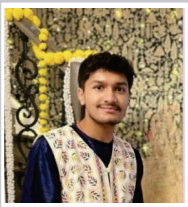
Name:	Helen Catan
Academic Institution:	Virginia Tech
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Attend grad school
NIST Laboratory, Division, and Group:	Fire Research Division
NIST Research Advisor:	Isaac Leventon
Title of Talk:	Testing and Analysis of Material Flammability through the Cone Calorimeter

Abstract:

The Cone Calorimeter, which was first developed in 1982 at NIST, was created as a means for predicting material flammability based on oxygen consumption. The device offered the efficiency and reliability that other instruments at the time could not. Since its development, years of data, including thousands of tests, have been stored on various devices and not touched since.

The project I am working on has two main parts. The first one involves storing all of the old Cone data, which will be condensed and processed, in a database where it is easy to find and view. For this effort I am teamed up with three SHIP students to find and organize all old data and write the scripts for processing them. The processed files should contain only the necessary data and metadata that we deemed important and useful when measuring flammability.

The second part requires me to calibrate and run tests on the Cone to collect new data for our database. The materials I'm testing cover a range of polymers and thermoplastics, which have a variety of different burning behaviors (e.g. charring, soot production, melting, dripping) and different heat release rates. I am also testing types of foams, which are highly flammable and will, along with the polymers and thermoplastics, provide useful info for predicting material flammability. This new data will be processed and stored in the same manner as the old data.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Varadraj Chavan
Academic Institution:	Georgia Institute of Technology
Major:	Biomedical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structural Systems Division, Infrastructure Materials Group
NIST Research Advisor:	Lipiin Sung
Title of Talk:	The Marine Microplastic Mayhem: Studying Plastic Degradation in Aquatic Environments

Abstract:

Plastic waste in the ocean degrades and releases microplastics into the aquatic environment, which may harm marine life. Quantifying and characterizing the release of these particles under realistic environmental conditions is essential for understanding their fate and assessing the fraction ingested by aquatic organisms. However, information on the fragmentation and size-based characteristics of released microplastics is largely unknown. My research aimed to evaluate the fragmentation and release of microplastics from polyethylene terephthalate (PET) plastic samples exposed to ultraviolet radiation and seawater. Samples immersed in ASTM (American Society for Testing and Materials)-standardized seawater were compared to those in the deionized water control group to evaluate the specific effects of seawater. They were both degraded using the NIST SPHERE (Simulated Photodegeneration via High-Energy Radiant Exposure) weathering device.

Throughout the exposure period, the plastic samples are periodically retrieved for various analyses. Fourier-transform infrared spectroscopy is conducted to study chemical changes, while confocal microscopy is employed to closely observe the surface of the samples. Color and gloss testing is performed to assess alterations in color appearance. The water PH is measured to detect the production of acid caused by the plastic degradation. By employing these techniques, we aim to systematically investigate the behavior of plastic under simulated weathering conditions, providing insights into the chemical, physical, and visual changes that occur. Through this research, we seek to enhance our understanding of the behavior and fate of microplastics in the aquatic environment. The findings from this study will contribute to the development of effective strategies for the identification, monitoring, and mitigation of microplastics, ultimately safeguarding environmental ecosystems and human health.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: McCarthy Devine	
Academic Institution: University of Colorado - Boulder	**Major:** Aerospace Engineering
Academic Standing (Sept. 2024):	Sophmore
Future Plans (School/Career):	Finish undergraduate degree, work in aerospace, attend graduate school
NIST Laboratory, Division, and Group:	Engineering Laborotory, Intelligent Systems Division, Emergency Response Robots and Drones
NIST Research Advisor:	Adam Jacoff
Title of Talk:	Developing and Practicing Standard Methods for Emergency Response Drones

Abstract:

The Emergency Response Robots project develops standard test methods to evaluate robotic systems used by first responders and their operators. Internationally, groups ranging from firefighters to militaries to bomb squads to the FAA have adopted these test methods to create a safer working environment for those who risk their lives every day. NIST's test methods have helped these groups evaluate how and which robots can replace or support humans in fatally dangerous tasks.

The first major project I contributed to was designing and developing standard test methods for the XPrize Wildfire competition. Using existing standardized test methods for drones as a template, we developed burnable and fire-free standard tests to represent incipient wildfires so that teams could evaluate their drone's ability to detect and extinguish incipient wildfires. This is the first time the project has successfully developed a test to evaluate fire-specific drone capabilities, and it included innovations like hinging branches, heat lamps, and even a new eight-sided structure.

The other focus of my time on the project was developing as a drone pilot and learning how to proctor drone proficiency tests. This project culminated in redesigning and flying a drone in the "ant-farm" labyrinth, which has two-foot-high ceilings and other obstacles. Another outcome of this project was using a drone concurrently with Spot, a quadruped robot. For the first time, we ran a test course with a drone and a robot simultaneously working together. This test replicates the future of emergency robots, scenarios where both drones and robots work together to increase the safety and efficiency of first responders.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

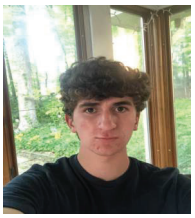
Name:	Eric Eng
Academic Institution:	Cooper Union
Major:	Electrical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Getting a PhD in Electrical Engineering
NIST Laboratory, Division, and Group:	Engineering Laboratory, Intelligent Systems Division, Manipulation and Mobility Systems Group
NIST Research Advisor:	Ann Virts, Mili Shah
Title of Talk:	Techniques for Recognition of Static Rotation Invariant Gestures

Abstract:

In recent years, hand gesture recognition has found increasingly useful application in the fields of human-robot interaction (HRI). Gesture analysis of human and robotic grasps may lead to development of new standards for exoskeletons. This motivates the development of an algorithm that is capable of classifying and characterizing hand grasps from image and video data.

The model will make use of MediaPipe Hands, an open-source hand landmarking algorithm part of Google AI Edge Solutions. This tool extracts hand landmarks from both image and video data, which can be used as a feature extraction layer for classification. Through this layer, a rotational profile of the hand could be generated by calculating joint angles across all landmark triples, resulting in 1330 possible features. Since many of these angles encode similar information, a dimension reduction step may be applied to vastly reduce the complexity of the classifier. Principal Component Analysis and Nonnegative Matrix Factorization were tested in extremely low dimensional cases.

Classification using joint angles theoretically induces rotation invariance of gestures, allowing for existing datasets to be leveraged to train for other purposes. One such idea is the classification of hand grasps, which are innately rotation invariant, using existing hand gestures. This extension circumvents the lack of an existing human hand grasp database and will hopefully allow for a preliminary analysis of grasping motions in the exoskeleton context.



SURF Student Colloquium

NIST – Gaithersburg, MD
August 13-15, 2024

Name: Christian Farias	
Academic Institution: Catholic University of America	**Major:** Computer Science
Academic Standing (Sept. 2024):	Sophmore
Future Plans (School/Career):	School: Complete Bachelors degree in Computer Science Career: Go into Game Development or Software Development
NIST Laboratory, Division, and Group:	EL-HQ (730)
NIST Research Advisor:	Kirk Dohne
Title of Talk:	Communications and Science: Illustrating Ingenuity

Abstract:

Science and Technology are vital aspects of our daily lives. They are apart of almost everything we do and have become the main front in innovation. For hundreds of years humans have been researching and discovering new ways to view and interact with our world. Scientists and reserachers has spent hundreds of years progressing the human race in all facits of life.

However, great research is sometimes lost because the language well understood and used by researchers to talk to colleagues fails to communicate and connect with others, and that limits the impact of the research. For this reason it is import to understand communications and it's role in science. Relaying information gained from research and development is a crucial part of progress as it allows for everyone to take part. According to National Academies report on communications, communications is the ability to relay information through various mediums. Good communications gives information in an understandable and practical way to the consumer.

Here in EL, communications are a central part of understanding what goes on and why it is important. That being said, many of the websites on EL's page are severely in need of a refresh. Between broken links, outdated info, and missing labs, there is a lot that needs to be updated so that EL's accomplisments, goals, and purpose are communicated well. My project contains a few steps:

1. Research and understand the needs of science communication,
2. Create a spreadsheet from various resources to identify needed fixes, additions, or updates,
3. Reach out to owners or contacts of pages and speak about the changes,
4. Update the webpages and ensure that the communication was true to the research.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Samantha Farren
Academic Institution:	A. James Clark School of Engineering
Major:	Fire Protection Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Fire/Life Safety Engineer with NASA Kennedy Space Flight Center serving the Artemis Mission
NIST Laboratory, Division, and Group:	Engineering Laboratory, Division 731, Infrastructure Materials Group
NIST Research Advisor:	Cody Strack
Title of Talk:	A Study of Concrete Materials using Optical Microscopy and X-ray Diffraction

Abstract:

The widespread use of concrete in infrastructure has led scientists to develop multiple ways of measuring and monitoring its structural integrity. This research uses microscopy, x-ray diffraction (XRD), and fluorescence microscopy to evaluate the structural integrity, potential deterioration, chemical/physical condition, and aggregate composition/distribution of concrete samples. Sample preparation for microscopy involved the polishing of material. Polishing was conducted manually with the use of water, a polishing wheel, and an assortment of grit polishing pads that were used in sequence, from 80 to 4000 grit. The microscopy for this research utilized a optical microscope integrated with a digital camera and a ultraviolet illuminator. These accessories enabled micrographs to be collected and allowed for analysis of 1” x 2” concrete thin sections pretreated with fluorescent dye. The system is further augmented by Petrog 5; a stepping stage and software package that enables data analysis. The data collected in this process is ultimately presented as a mosaic of micrographs, composed using polarized or plane light, which allows visual evaluation of the composition and potential degradation of the material. Lastly, when using ultraviolet light to excite the fluorescent dye embedded in the sample, specific characteristics of the material are more vividly presented, such as pore size, microcracks, and the water-to-cement ratio.

The XRD portion of this research made use of a diffractometer and an open-source software package, Profex 5.3.0, to analyze a powdered concrete sample set. Sample preparation for XRD analysis included crushing, separating, and sieving sample content before placing, tamping, and setting the sample powder into XRD mounts. The data provided by XRD analysis involves diffraction patterns indicative of the sample’s crystallographic structure, physical properties, and composition. The culmination of the aforementioned techniques provided highly technical insights into the chemical and physical properties of concrete samples in various stages of their serviceable lifespan.

SURF Student Colloquium

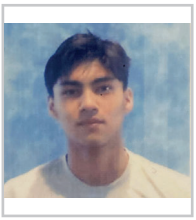
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Kyle Foster
Academic Institution:	Miami University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Work in mechanical engineering industry and obtain a masters degree
NIST Laboratory, Division, and Group:	Engineering Laboratory, Systems Integration Division, Life Cycle Engineering Group
NIST Research Advisor:	Nehika Mathur
Title of Talk:	Adapting the Bass Diffusion Model to forecast critical material demands for clean energy technologies

Abstract:

In our worldwide goal of reaching a net zero carbon emission economy, a successful solution lies within the circular economy. Many products throughout our economy rely on critical materials, that are important to the clean energy industry and our transition to a circular economy. Critical materials are however prone to supply chain risks. Moreover, the market for these materials is very complex, as there are different factors that contribute towards materials criticality. The main factors include little to no recovery from used products, processing challenges and geopolitical complexities. These uncertainties because of these complex market dynamics makes it very difficult to predict future market demands for these materials, which is essential in ensuring a steady stream of these materials. With a steady stream of these materials, we can enable a smooth ramp up for the adoption of clean energy technologies. Identifying critical materials and predicting their future demands over the next few decades is vital for firms as well as governments. Determining future raw material demands will contribute towards developing effective strategies to support our transition to a decarbonized and circular economy. This work applies the Bass Diffusion Model to forecast critical material demands. First, we identified the materials currently most critical to support domestic decarbonization goals based on scientific literature and by the US Department of Energy (DOE). Subsequently using the historical production data found in the scientific literature for each of these materials, curve fitting is applied to obtain the Bass coefficients of imitation (p) and adoption (q). Thereafter, coefficients p and q are applied to the Bass Diffusion Model to obtain future demands for each shortlisted material. The Bass Diffusion Model is scripted in Python and has been used to forecast critical material demands until 2050.



SURF Student Colloquium

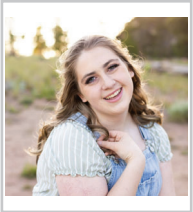
NIST – Gaithersburg, MD

August 13-15, 2024

Name: Juan Carlos Gauna	
Academic Institution: St. Mary's University, TX	**Major:** Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	EL, 730, Applied Economics
NIST Research Advisor:	Dr. Christina Gore
Title of Talk:	Multi-Label Classification of Disaster Tweets using Transformer-based and Deep Learning Models

Abstract:

Qualitative text analysis has broad applications across multiple disciplines, including community resilience. The categorization of text-based social media posts can be used to evaluate how discussions surrounding increasing resilience to future natural hazard events evolve following the hazardous event. This paper uses a data set of 2,200 tweets from X in the case of the 2013 Colorado Flood and the 2012 High Park Fire. Categorization tasks into user-defined labels can be partially facilitated with supervised deep learning, and automated with a trained model. In this paper, transformer-based and deep learning models are developed for supervised multi-label classification of the redundantly labeled social media posts. The accuracies of the models are evaluated with macro-F1 scores and the labeled social media posts are analyzed. Automated categorization will reduce the time spent labeling tweets and allow researchers to label larger datasets, enabling previously inaccessible research questions to be addressed.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sydney Holles
Academic Institution:	Illinois Institute of Technology
Major:	Architectural Engineering
Academic Standing (Sept. 2024):	Senior/ 4th year
Future Plans (School/Career):	Attend accelerated masters program at my university to get my M.Eng in Structural Engineering and then begin working in industry
NIST Laboratory, Division, and Group:	Engineering Lab, Division 732, Mechanical Systems & Controls
NIST Research Advisor:	Mike Galler
Title of Talk:	Investigating Building Performance Using Cx Software

Abstract:

HVAC systems are often the largest draw of energy within a building. To lower the Energy Use Intensity of a building, lowering the energy use of the HVAC system will cause the greatest impact. Using Building Commissioning software (HVAC-Cx), we are able to evaluate the HVAC system at the Montgomery College Robert E. Parilla Performing Arts Center. Using the commissioning software, we are able to look at any faults that the system may be having, through fault reports and by observing the data the sensor collects on graphs generated by the software. Using this information we are able to find common faults that may be occurring, see if there are broken sensors, and evaluate the overall functioning of an HVAC system. Data from the Performing Arts Center is being evaluated from February 2023 to June 2024, and findings are being reported to Montgomery College. With our current findings, improvements to the HVAC system at the Montgomery College Performing Arts Center that could be made are: new/improving the supply air sensors, the return air sensors, and the mixing air sensors, as well as significant improvements to both the heating and cooling coils.

SURF Student Colloquium

NIST – Gaithersburg, MD
August 13-15, 2024

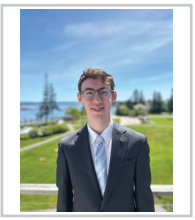
Name:	Philip Huang
Academic Institution:	University of Maryland, College Park
Major:	Computer Engineering
Academic Standing (Sept. 2024):	Junior/3rd Year
Future Plans (School/Career):	Pursue Masters
NIST Laboratory, Division, and Group:	Engineering Lab, Fire Research Division, 733
NIST Research Advisor:	Isaac Leventon
Title of Talk:	Operation/Automation of TGADSC and Construction of Intermediate Scale Flame Spread Apparatus

Abstract:

Every material reacts to rising temperatures differently. One can record and analyze said reactions, such as mass loss rate and heat flow, through machines that monitor materials in a temperature and gas-controlled environment. With the densely collected data, the goal is to process and feed the corresponding data into an overarching automated database containing scripts, figures, and data that updates frequently and presents organized statistical analysis of our results from the TGADSC, as well as other past and ongoing NIST Fire Research projects.

Therefore, in consideration of that vision, I conducted various calibrations and sample tests with the TGADSC, with the TGA measuring mass loss changes as the sample was heated at a constant rate, useful in determining mass loss rate and decomposition reactions, and the DSC recording heat flow through that same material, visualizing phase transformations and thermodynamic properties for review. In the ongoing development of automated backend processes, I worked to programmatically construct and refine the process of converting and transferring all data from machines to a user-friendly interface displaying a variety of easily digestible statistical analyses via carefully iterated Python scripting.

With the TGADSC and backend processes in routine, my main project consisted of the construction of an apparatus that collects validation data through gauging the partitioning of convection vs. radiation of flames at differing height levels of a flames, handled by the Intermediate Scale Flame Spread Apparatus (ISFS). The ISFS consists of plates fashioned with radiometers and thermocouples supporting sample slabs to face the flame ignited by a 5kW propane burner mounted on a sliding cart just below the base of the sample. Additional to the focus of radiation/convective spread, the apparatus measures the vertical fire spread rate, wall flame heat flux, mass loss rate, flame sheet temperature, and heat release rates of natural and synthetic polymers.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Timothy Jacob
Academic Institution:	Vanderbilt University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Explore Industry; Graduate School
NIST Laboratory, Division, and Group:	Engineering Laboratory; Division 731; Community Resilience Group
NIST Research Advisor:	Dr. Emina Herovic
Title of Talk:	Insights on Emergency Communication Protocol and Standards

Abstract:

A comprehensive and systematic review of communication infrastructure and protocol was conducted across countries to ascertain areas for improvement, best practices, and cross-country insights. Literature, which included government reports, government standards, journal articles, news articles, and government web pages, was evaluated and compared across countries with sufficient publicly available information on their respective risk communication practices. The communication mediums of focus for this study were: radio, television, mobile alerts, and social media. Relevant data were extracted both manually and via a coding script designed to read and extract pertinent information. Preliminary insights indicate comprehensive disaster communications networks capable of quickly disseminating information to residents with potential room for improvement of message dissemination and protocol procedures which may be prone to human error. Additionally, preliminary insights indicate a need for better transparency of communication protocol and a lack of sufficient guidance for some communication mediums, which can lead to varying usage and protocols.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Benjamin Johnsson
Academic Institution:	Grove City College
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate with my bachelor's degree and pursue a master's degree
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structures Systems Division, Infrastructure Materials Group
NIST Research Advisor:	Ashley Carey
Title of Talk:	Effects of Sealants on Concrete Permeability

Abstract:

Pyrrhotite, an iron sulfide mineral similar to pyrite, has been found in concrete foundations in multiple countries over the past decades. In the U.S., pyrrhotite has been found to be the root cause of premature concrete cracking in Connecticut and Massachusetts foundations. The presence of both water and oxygen causes pyrrhotite within the concrete aggregate to oxidize, creating a volume increase due to oxidation byproducts. Additionally, sulfate produced during oxidation reacts with the cement paste surrounding the aggregate, forming byproducts of internal sulfate attack and causing further expansion. These cumulative volume increases cause premature cracking of the foundation, which may not be visible until decades after the foundation is poured.

Sealants are a possible method to slow down or prevent future oxidation of pyrrhotite within foundations which have not cracked yet or show a low amount of cracking. Methods evaluating the effectiveness of sealants on concrete for the pyrrhotite issue need to be studied further. One method tests oxygen permeability using the Controls Group Oxygen Concrete Permeameter which uses 6-inch diameter by 2-inch thick concrete specimens. This study had three major objectives. First, testing was conducted to validate the accuracy of the testing equipment by comparing traditional soap bubble flow meters to a digital mass flow meter. Second, concretes with three different water/cementitious material ratios (w/cm) and non-pyrrhotite bearing aggregate were made to test the difference of oxygen permeability between concrete of the different w/cm ratios. Third, specimens of the same ratio (0.45) were sealed with either lithium silicate or epoxy, or left unsealed, to test the effects of these sealants on oxygen permeability. Other sealants such as silane and a cementitious layer with acrylic are to be tested in the future.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sarah Lehrman
Academic Institution:	University of Maryland, Baltimore County
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate and take the Fundamentals of Engineering exam
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structural Systems Division, Earthquake Engineering Group
NIST Research Advisor:	Jazalyn Dukes
Title of Talk:	Analysis of Fiber Reinforced Polymer (FRP) Retrofitted Shear Walls with Openings

Abstract:

Reinforced concrete (RC) walls are concrete walls with internal reinforcing steel bars. RC shear walls are designed to resist lateral loads, particularly seismic forces from earthquakes. Excessive lateral loading can lead to failure in existing buildings, where an earthquake can cause brittle failure in shear walls. This is particularly a concern for older buildings, especially those built before 1970 and the modern seismic codes. It is difficult to fully prevent this failure, however it is possible to change the failure mode to flexural failure through retrofitting. Fiber reinforced polymers (FRP) are composite materials that consist of a polymer matrix and fibers. FRP sheets are strong but thin, and have been used for retrofitting various concrete structures. However, their implementation on RC walls has not been greatly studied. This project primarily focuses on the effects of the implementation of FRP composites on RC walls with openings.

A database for RC walls with openings was created in excel, which compared the failure behavior of un-retrofitted walls to FRP retrofitted walls. This database includes geometric properties, material properties, and failure modes and details for each specimen, which was gathered from various literature. A digitizer software was used to create load-displacement backbone curves that compared the lateral load to the drift ratio. These backbone curves were used to determine the control points for each specimen. This database was used to create histograms to compare different properties, such as aspect ratio, axial load ratio, and reinforcement ratios.

This database will allow future researchers to compare the performance of different retrofitting procedures, as well as determine the most effective methods of retrofitting walls based on their geometric and material properties. This database will be used to analyze the behavior of retrofitted walls with openings by developing relationships between certain wall characteristics and the backbone curve control points, and proposing equations to explain behavior of the walls.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Anna Liu
Academic Institution:	Swarthmore College
Major:	Economics and Computer Science
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Graduate school
NIST Laboratory, Division, and Group:	Engineering Laboratory, Applied Economics Office
NIST Research Advisor:	Jennifer Helgeson, Christina Gore
Title of Talk:	Climate Change and Resilience Sentiments Following a Natural Hazard Event

Abstract:

With average global temperatures rising, climate change is expected to intensify the severity and frequency of natural hazard events. During such events, social media sites and Google are major platforms for sharing and receiving emergency information and connecting community members. The project investigates changes in discussions over time surrounding climate change and resilience immediately following the 2012 Colorado Wildfires and 2013 Colorado floods. The analysis utilizes data from Google Trends and a 2,200 tweet dataset from X (formerly known as Twitter). Tweets are coded based on types of sentiments expressed by the tweets and then analyzed based on trends. Commonly used keywords found in these tweets are used to help inform Google trends search criteria data. Understanding changes in these sentiments is integral to understanding public perceptions and ultimately helping communities build resilience to respond to, withstand, and recover from future natural hazard events and mitigate the impacts of climate change.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Ethan Nowery
Academic Institution:	University of Nevada, Las Vegas
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Finish Bachelor's and then start my Master's Degree in a robot related degree
NIST Laboratory, Division, and Group:	Engineering Laboratory, Division 735, Robot Test Facility
NIST Research Advisor:	Alex Fraley
Title of Talk:	Testing Terrain Traversal, Dexterity, and Visual Acuity of Legged and Tracked Ground Robots

Abstract:

Robotic integration with human society no longer only exists in science fiction media, it is a novel and experimental technology on the verge of being deployed for widespread applications in the real world. NIST's Emergency Response Robots project is developing standard test methods to support systematic integration of robots into emergency response operations where the risk to human life is often fatal. While this technology evolves and becomes more advanced, there is a need for testing and evaluating to evolve as well. This work was conducted as part of the standardization process for these tests that will enable a wide variety of users to evaluate their own robot capabilities and remote operator proficiency. This presentation highlights some of the various test methods I helped develop to measure and compare the mobility, dexterity, and visual acuity of a tracked robot and a legged robot. Some examples of groups deploying these test methods include: setting up a newly combined robot and drone tests at the U.S. Capitol Police Training Facility near Washington, D.C. (June), validating modified test designs for the RoboCupRescue International Championship in the Netherlands (July), capturing robot capabilities data for the NATO Committee on Robot Dexterity for Explosive Ordinance Disposal (July), and developing and validating new tests to be used at the World Robot Summit Disaster Response Challenges in Japan (October).

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Weiheng Oh
Academic Institution:	Rensselaer Polytechnic Institute
Major:	Environmental Engineering
Academic Standing (Sept. 2024):	Third-year undergraduate
Future Plans (School/Career):	Pursue a Master's in Civil Engineering
NIST Laboratory, Division, and Group:	Engineering Lab - Division 732 - Group 2, Mechanical Systems & Controls
NIST Research Advisor:	Natascha Milesi-Ferretti
Title of Talk:	Pressure loss in pipe fittings / Condensation of two-phase flow in microchannels

Abstract:

Premise plumbing design is still based on methods developed in the early 20th century. To help modernize the methods that plumbing design is based on, a testing rig for measuring pressure losses in pipe fittings was designed and constructed at NIST previously (before the current student). Using this rig, data is being collected for pressure losses of single-phase flow of water for several different pipe elbows. The collected data is analyzed in order to produce an estimated pressure loss constant for each fitting.

In addition to single-phase flow, two-phase flow of refrigerants was studied. The flow and heat transfer characteristics of two-phase refrigerant during evaporation or condensation are important to the design of heat transfer equipment for heating and cooling systems. In this work, a database was established by digitizing the data from several papers to validate an existing NIST model. The data includes the heat transfer coefficient, film thickness, and the mass flow rate. A python script was developed to process the data and to graph the calculated parameters to help analyze the effective range of the existing NIST model.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Shine Park
Academic Institution:	The George Washington University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Undecided.
NIST Laboratory, Division, and Group:	Engineering Laboratory, 733 Fire Research Division
NIST Research Advisor:	Amy Mensch
Title of Talk:	Measuring Soot Deposition on Surfaces Using Grayscale Image Analysis

Abstract:

The analysis of soot deposition, in the context of fire forensics, is used to infer the critical elements of a fire in a post-fire investigation. Measurements of soot deposition are also useful for validating fire models, such as NIST's Fire Dynamics Simulator, which are used to make life-safety predictions, like visibility or smoke toxicity during a fire. The goal of this research is to see if there are any limitations when measuring soot depositiong through image processing. To conduct this research, two types of material boards, gypsum and steel, were put over a flame at different heights for different durations of time, which changed how much soot would be deposited on each board. Each board additionally had aluminum targets that were weighed before and after the fire to determine how much soot mass was collected. Images of the board were then taken, and image analysis was done via Matlab. Each image was converted into a grayscale image, and for a certain area on the target, the average grayscale value was calculated and then compared to the soot mass that was found gravimetrically. Additionally, the grayscale values were also calibrated to find the optical density equivalent using Image J, and the optical density values were also compared to the mass loadings. When observing the graphs, in particular, the Mass Loadings vs. the Average Grayscale value graph, for mass loadings greater than around 400 mg/m^2, the average grayscale values seem to level off. This demonstrates a limitation in viewing soot deposition through grayscale image analysis, as even though the mass load increased, the grayscale value roughly stayed the same. In contrast, the Mass Loadings vs. Optical Density graph shows a more linear relationship between the two values, but there is more scatter in the points, which is introduced during the optical density calibration. One limitation of using image analysis for soot measurements that was observed during this research was the quality of the photos. Some photos, especially those of the metal boards, had light reflections which made some sections have a higher grayscale value, which ultimately affected the average grayscale value calculated through Matlab, and consequently the optical density.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Terrence Pierce

Academic Institution: University of Maryland, College Park

Major: Mechanical Engineering

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career): Pursue a Ph.D. in mechanical engineering and become a professor

NIST Laboratory, Division, and Group: Engineering Laboratory

NIST Research Advisor: Prem Rachakonda

Title of Talk: Evaluating 3D sensor performance using planar targets

Abstract:
As image-based machine learning and uncrewed vehicles continue to grow in popularity, so too will the technology feeding their algorithms, namely sensors which obtain 3D and RGB images of surroundings. Therefore, it is crucial to determine which conditions affect the sensor outputs and how the output is affected. The 3D stereo sensors being evaluated for this work are typically used in applications such as robotic bin picking, industrial automation and autonomous navigation. This study will detail the transient and spatial effects of the 3D stereo sensors as well as the dynamic responses such as the accuracy of sensors in motion and time for different data processing techniques to gain insight into their industrial application. This study will analyze how different conditions affect the various forms of sensor noise, including light conditions, types of startup, total capture time, and more. This work will enable end-users to make informed decisions on investing in technology that meets the needs of their application.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Tiegan Powell	
Academic Institution: NYU	**Major:** Physics
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	PhD in Physics
NIST Laboratory, Division, and Group:	Engineering Lab-->Intelligent Systems Division-->Mobility and Manipulation Group
NIST Research Advisor:	Yong-Sik Kim
Title of Talk:	Investigating Shape-From-X Programs for Object Geometry Reconstruction

Abstract:

In computer vision, shape-from-X techniques play a crucial role in recovering object shapes from visual data. These methods, such as shape-from-shading and shape-from-motion, focus on reconstructing 3D structures from 2D images or video frames by detecting changes within and between frames.

This project aims to utilize shape-from-X techniques to recover the 3D shape of objects impacting a transparent gel elastomer, which mimics human skin. Integrating force sensor measurements with the reconstructed geometry will create a force distribution map, offering insights into the impact forces experienced by the simulated tissue, especially in challenging areas like edges and corners. These distributions aim to enhance safety standards for Human-Robot Collaboration in compliance with the ISO/TS 15066 guidelines.

Due to the prominence of visual tactile force sensing in robotics, numerous commercial products and open-source projects utilize shape-from-X programs, so we are looking for Github repositories that can be utilized and modified for our project. We also are looking at native Matlab programs and libraries, such as the Computer Vision Toolbox, as another way to implement one of these shape-from-X techniques into our project.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Natanel Solomonov		
Academic Institution:	University of Maryland, College Park	**Major:**	Computer Science w/ Statistics minor
Academic Standing (Sept. 2024):	Sophomore		
Future Plans (School/Career):	Software Engineering / Cybersecurity		
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structural Systems Division, Community Resilience Group		
NIST Research Advisor:	Dr. Dylan Sanderson		
Title of Talk:	Verification and Validation of Computational Models for Analyzing Future Impacts of Sea Level Rise		

Abstract:

Community resilience is defined as the ability of communities to prepare for anticipated hazards, adapt to changing conditions, and withstand and recover rapidly from disruptions. Sea level rise poses significant threats to coastal communities as it has the potential to negatively impact both infrastructure and households. Given this threat, new computational models for community resilience planning are needed to help communities prepare for future hazards. To better understand and predict how sea level rise will impact future communities, I have been working on the verification and validation (V&V) of an agent-based model (ABM) of household adaptation to sea level rise. In this ABM, agents respond to future exposure to sea-level rise and make decisions regarding adaptation using reinforcement learning. Galveston, Texas is used as a testbed community as it is potentially subject to over 2 feet of sea level rise in the next 100 years. Multiple V&V tests were performed such as comparison to other models and sensitivity analysis. Regarding comparison to other models, I evaluated three different agent decision-making mechanisms: (1) agents consider their exposure to sea level rise, (2) agents use a reward signal, and (3) agents use utility theory and Cobb-Douglas utility functions. Sensitivity tests using the reinforcement learning model were then performed and showed how the agent decision-making process is sensitive to the agent's reward signal. The results demonstrate the difference between two different ABMs, one that uses reinforcement learning and one that does not, along with representing how both predict agent behavior.

SURF Student Colloquium

NIST – Gaithersburg, MD

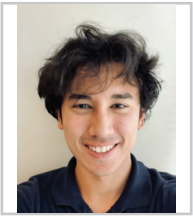
August 13-15, 2024

Name:	Jacqueline Stensland
Academic Institution:	Tufts University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Sophmore
Future Plans (School/Career):	Pursue a Master's Degree
NIST Laboratory, Division, and Group:	EL 731 IMG
NIST Research Advisor:	Patrick Dixon
Title of Talk:	Reactivity and Expansion of Iron Sulfides in Cement

Abstract:

In eastern Connecticut, thousands of residential foundations are at risk of deterioration. About 35,000 homes are built on concrete foundations made with pyrrhotite bearing aggregate. Pyrrhotite is an iron sulfide that is attributed with causing deterioration. The concrete deterioration is a result of a two-part expansive reaction. First, the pyrrhotite oxidizes. This oxidation releases sulfate by-products that react with the cement hydration products and cause an internal sulfate attack in the concrete. Both reactions are expansive and result in gradual cracking of the foundations. Over the course of 10 to 20 years these foundations become so dilapidated that they require replacement at an average cost of 150,000 to 250,000 USD. Communities in Ireland and Canada have faced similar problems. With the goal of avoiding similar problems in the future, limits are being put on the maximum quantity of pyrrhotite and other sulfides allowed in concrete aggregate.

This project examines the reactive potential of common sulfides in a context that resembles concrete. The length change of miniature cement bars, i.e., their expansion, is measured to determine the deleterious reactive potential, aligning with the general use of expansion measurements for aggregate reactivity assessments. Three different sets of bars containing equal percentages of a different iron sulfide, pyrrhotite, pyrite, and chalcopyrite, are compared to a set of bars containing only neat cement. The bars are all subjected to the same conditions, a continuous bleach soak after a 3-day cure with regular length and mass measurements over the course of their submersion. Bleach is typically used in sulfide aggregate tests because it mimics the pH of cement pore solution and acts as an oxidizer to expedite the deterioration. By comparing expansions, this project aims to illuminate the danger each iron sulfide poses in aggregate. These results can be used to initially consider limits of various sulfides in aggregates as communities try to avoid similar problems in the future.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Alec Tripi	
Academic Institution: The George Washington University	**Major:** Biomedical Engineering
Academic Standing (Sept. 2024):	Graduate Student
Future Plans (School/Career):	This fall I will begin my Master's Degree in Biomedical Engineering
NIST Laboratory, Division, and Group:	Engineering Laboratory (EL), Fire Research Division (733), Fire Research Group (FRG)
NIST Research Advisor:	Dr. Isaac Leventon
Title of Talk:	Development of the Molecular Weight Apparatus and Construction of the CAPA II

Abstract:

Pyrolysis plays a crucial role in understanding the behavior of materials. It involves the thermal decomposition of combustible materials in the absence of oxygen, leading to the release of volatile gasses, liquids, and solid residues such as char. This process is essential for modeling and predicting fire dynamics, as the gasses and vapors produced during pyrolysis can ignite and contribute to flame spread and intensity. By studying pyrolysis, researchers can gain insights into the flammability of materials, develop fire-resistant materials, and improve fire safety protocols. In this project, pyrolysis research is advanced through the development of two experimental apparatuses: the Molecular Weight Apparatus and the Controlled Atmosphere Pyrolysis Apparatus II (CAPA II). These tools will further the study of flammable materials at NIST, and the data collected from experiments run in these vessels will assist in the development of a comprehensive Material Flammability Database.

The development of the Molecular Weight Apparatus involves standardizing experimental procedures, identifying and eliminating sources of potential error, and processing steady-state data using a series of Python scripts. The organization and processing of the collected data is also an important aspect of this project that will provide important information on the decomposition kinetics of certain materials. Throughout experimentation, samples such as POM, PMMA, different types of wood, miscellaneous polymers, and several other substances were pyrolyzed in the chamber with data being collected for each.

This project also involves the construction and commissioning of The Controlled Atmosphere Pyrolysis Apparatus, a scaled down version of the NIST Radiative Gasification Apparatus. CAPA II is a state-of-the-art tool for analyzing the pyrolysis of charring and intumescent polymers. This apparatus provides precise measurements of mass loss rate, temperature distribution, and sample shape changes under radiant heating. Its controlled gaseous environment, accounting for heat flux non-uniformities, and open-to-the-atmosphere design enhances experimental diagnostics and facilitates a better understanding of oxygen's impact on pyrolysis. My project constructing this apparatus includes designing the gasification chamber, routing the water, gas, and power lines to the components, validating the sensors, analyzers, and other data acquisition units, and integrating real-time data collection software.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Nelson Tucker
Academic Institution:	Millersville University
Major:	Meteorology
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue Graduate School or PhD for tornado research
NIST Laboratory, Division, and Group:	Engineering Laboratory, Materials and Structural Systems Division, Structures Group (731.01)
NIST Research Advisor:	Marc Levitan
Title of Talk:	Developing a Database of Tornado Strikes on Warehouse-Type Structures

Abstract:

Tornadoes pose a significant threat to life and property. Recent years have seen several notable strikes on "big-box" and warehouse type structures. A growing number have resulted in either high casualties, or widespread societal and economic repercussions. Relatively little, however, is known about the nature, frequency, and cumulative national impacts of these incidents.

In conjunction with efforts to document hits on critical facilities such as schools and emergency services, warehouses are now being looked at more closely. A database is being created of post-2008 strikes that will aid both researchers in understanding the characteristics that make these incidents so damaging, and assist communities in making decisions about tornado resilient designs. In combination with SHIP students this summer, mining for the information has been conducted on the National Weather Service's Damage Assessment Toolkit (DAT). However, inconsistencies in the level of information gathered in the Toolkit indicate that this may be an undercount.

This study first overviews the results of the mining. It then explores the true success rate of this documentation by comprehensively analyzing several tornado tracks in high population zones. The numbers found from those detailed looks will be contrasted with results from the same tornadoes in the DAT to quantify the thoroughness of the database.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Kelsi Wood
Academic Institution:	Colorado School of Mines
Major:	Computer Science
Academic Standing (Sept. 2024):	Graduate Student
Future Plans (School/Career):	Get a MS in Engineering and Technology Management
NIST Laboratory, Division, and Group:	Engineering laboratory, Division 732-1, Digital Building Twins
NIST Research Advisor:	Parastoo Delgoshaei
Title of Talk:	Custom Digital Building Twins 3D Models to Graphs

Abstract:

Semantic Web technologies offer new possibilities for efficiently managing information and knowledge in the built environment. Employing semantic models of buildings in building analytics reduces deployment costs and enhances intelligent control across structures. This project aims to explore the use of software tools to generate RDF (semantic) models of prototype buildings, utilizing Building Information Models (BIM) in accordance with the evolving ASHRAE 223 Semantic Schema for Analytics and Automation Applications in Buildings. The digital twin model will be applied to various building functionalities, including Fault Detection and Diagnostics (FDD), context-aware control, and indoor air monitoring. Our current path involves exploring how to transform Revit models, which are a 3D building model format, into a graph by converting them into GBXML (Green Building XML) files. GBXML is a schema for sharing building information, facilitating interoperability between building design and analysis tools. This format is then converted to JSON (JavaScript Object Notation), a lightweight data-interchange format that is easy for humans to read and write, and easy for machines to parse and generate. Following that, the JSON file is converted to JSON-LD (JSON for Linked Data), a method of encoding Linked Data using JSON. JSON-LD allows for integrating data across different documents and APIs, enabling richer data connections. Finally, we use the JSON-LD file and several built-in Python functions to create a custom ASHRAE 223 graph.

SURF Student Colloquium

NIST – Gaithersburg, MD

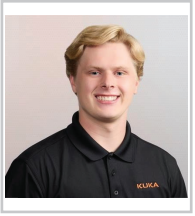
August 13-15, 2024

Name:	Nihar Xavier
Academic Institution:	University of Maryland
Major:	Computer Engineering
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	I plan to finish my degree, then work as an engineer or consultant at a technology company.
NIST Laboratory, Division, and Group:	Engineering Lab - Fire Research Division
NIST Research Advisor:	Dr. Eric Mueller
Title of Talk:	Using the Fire Dynamics Simulator (FDS) to evaluate wildfire model accuracy at varying complexities

Abstract:

The Fire Dynamics Simulator (FDS) is an open-source Computational Fluid Dynamics (CFD) tool that models fire spread in various environments, including wildlands. The ability to predict fire growth and behavior in wildland fuels is vitally important to ensure the safety and security of the people who inhabit these spaces. Such CFD simulations have the potential to be very computationally demanding; however, the most detailed representation of the underlying physics is not always required for sufficient predictions of the variables of interest, such as an accurate reading of where and how quickly a fire may spread. Because there are so many different variables and physical submodels that can be used in the modeling of these fires, it is important to know which will have a meaningful effect on the simulation, if added. Ideally, the accuracy and predictability of fire models increase as the resolution and number of variables introduced increase, but at a rate of diminishing return as the solution converges. Because of this principle, it is up to researchers to find the correct balance between the speed of computation and the accuracy of the simulation to find both a time-efficient and accurate simulation. To answer the question of accuracy, FDS uses many validation cases that assess the model outputs against well-controlled and highly instrumented experiments that reflect real-world fire scenarios of interest. However, for fire spread in wildland fuels, the availability of such data is limited.

In this project, we investigate a recent research study involving a well-instrumented experimental grassland fire. This project, FireFlux II, was aimed at capturing the effects of fuel and wind conditions on fire spread, and we set out to reproduce this scenario in the FDS software. We look at how accurate the model is with varying levels of model physical complexity and resolution. In particular, we focus on including dynamic feedback between ambient atmospheric wind and fire-induced winds. We hope to find a balance between a good time complexity and high accuracy for this validation case.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Beck Tapert
Academic Institution:	Lake Superior State University
Major:	Robotics and Computer Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a career in robotics and automation
NIST Laboratory, Division, and Group:	Engineering Lab, Intelligent Systems Division, Agility Performance of Robotic Systems
NIST Research Advisor:	William Harrison and Justin Albrecht
Title of Talk:	Bridging the gap between robotics research and the standard industrial robotic work cell

Abstract:

Robotics plays a clear and inevitable role in our technical future; however, novel research and techniques often fail to make it onto the manufacturing floor. This is because a gap exists between robotics research and industrial robotic implementation. This project seeks to explore and document the differences, similarities, and benefits of both industrial robot work cells and the typical robot research environment. One aspect of some robotic research work cells is the ability to interact with robots in a robot-agnostic manner that allows all components of a robotic work cell to communicate using the Robot Operating System (ROS). The ability to use ROS is one aspect of robotic research which has not translated to the manufacturing floor. Further, this project aims to document the development of a ROS hardware interface and its capabilities, which can provide insightful information on the translation of robotic research onto the manufacturing floor. Additionally, the documentation will provide important information about porting preexisting ROS industrial drivers into ROS2.

In an industrial robotic work cell, robot programming is typically done through proprietary software provided by the robot manufacturer, whereas research often uses an open-source method. This project will document the development of a ROS2 hardware interface for the Fanuc lrmate200id which uses work from the ROS-Industrial Fanuc driver. ROS-Industrial is an open-source community-driven framework that has developed various drivers for industrial equipment. This project will document the process of moving that software into the newer ROS2 framework used for modern research. Bridging the gap by providing researchers with a means to control a Fanuc lrmate200id which can be used to recreate real-world industrial automation challenges and showcase the capabilities of robotic research in industry. Finally, this project will provide industry with the information necessary to replicate research solutions in industry.

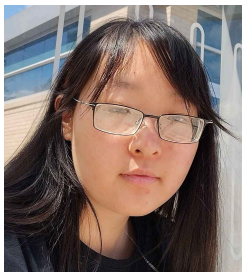












Information Technology Laboratory 2024

Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Information Technology Laboratory (ITL)

William Lee - **ITL plenary speaker**	Image restoration to improve face recognition outcomes – Does it really work (and how do we
Mikhail Krepets	Walk on Spheres Improvements for ZENO
Davis Ford	Speeding Up TestU01 with Threads
Faadil Shaikh	Studying the Effects of Using Triangular Meshes in ZENO on Accuracy and Speed
Daniel Choi	Photoluminescence Mapping of Vanadium Defects in SiC for Quantum Technology Application
Irving Shi	Creating a Power Grid Topology Simulation
Shawn Pourifarsi	Exploring and Addressing the Limitations of Shaders in Paraview
Lilian Xiao	Improving Lighting in Immersive 3D Scientific Visualization
Alexander Liu	Extending Tools for Physical Measurement in Virtual Environments in Paraview
Sydney Lee	Enhancing cytometer data collection with a high-speed neuromorphic camera
William Deye	Radial Basis Functions and Biological Field Effect Transistors
Thomas Wolcott	Using Discrete Variable Representation to Solve the 1D TDSE
Evan Liu	Measurements from Event-based and Frame-based Cameras
Akhilesh Reddy	Mapping Uncertainty for Image Classification
Anna Li	Exploring the Use of Digital Twins to Generate Ground Truth for AIs
Jeffrey Howard	Standards as Discourse
Marianne Nguyen	Web App for Measurement Error Models
Andrew Zhang	Advancing Deepfake Defense: Building a Comprehensive Generative-AI Detection Dataset
Vicky Lee	Judging Large Language Models on Generating Relevance Judgements
Francis Durso	Optimizing Data Binning for Enhanced Accuracy in Classification Algorithms
Shraddha Hardikar	Neural-Network Based Cryptanalysis
Megha Jasti	Implementing m-NGAC in Oracle for Off-the-Shelf Fine-Grained Access Control
Madison Catterton	Creating and Securing a NLP tool for the NCCoE website
Miles Walker	A Case Based Human Reliability Assessment Using the Human Factors Analysis and Classification System (HFACS) Framework for the Systems Security Management Work Role
Joey See	Area-based Trojan Prevention for Open Source Silicon Design
Christopher Su	Power Side Channel Analysis

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Madison C. Catterton
Academic Institution:	Univeristy of Maryland, Baltimore County
Major:	Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Finish my Bachelor's degree, gain experience in working in my field before going for my Master's
NIST Laboratory, Division, and Group:	ITL - National Cybersecurity Center of Excellence
NIST Research Advisor:	Tim McBride
Title of Talk:	Creating and Securing a NLP tool for the NCCoE website

Abstract:

The National Cybersecurity Center of Excellence (NCCoE) has developed over 50 Practice Guides in partnership with Industry to address critical problems across multiple industry sectors in the United States. Natural Language Processing (NLP) and Retrieval-Augmented Generation (RAG) tools are a rapidly evolving capability that can be leveraged to assist in the adoption of NCCoE Guidance by industry. A way to make the information in this corpus of resources more accessible to the public and internal resources is to create a natural language processing tool for the NCCoE Website. The natural language processing tool is a RAG model which uses a combination of relevant Documents and a pretrained model to generate a response based only on the given information.

The NLP tool will be tested to ensure that accurate results are presented to visitors to the NCCoE website. Another focus for production of the tool is to secure the tool against malicious attacks such as RAG poisoning that can be easily done through prompt injection. The main concerns is that through RAG poisoning a malicious actor can force the RAG to give incorrect or harmful information.

SURF Student Colloquium

NIST – Gaithersburg, MD

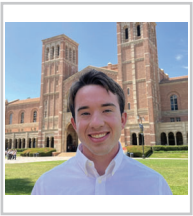
August 13-15, 2024

Name: Daniel Choi			
Academic Institution:	Arizona State Univerisity	**Major:**	Electrical Engineering
Academic Standing (Sept. 2024):	4.0		
Future Plans (School/Career):	Pursue graduate studies in quantum technology		
NIST Laboratory, Division, and Group:	Division 771, Information Technology Laboratory		
NIST Research Advisor:	Dr. Ma, Lijun		

Title of Talk: Photoluminescence mapping of vanadium defects in SiC for quantum technology application

Abstract:

Quantum network promises applications that are beyond the reach of classical network, including distributed quantum computing, secure quantum communication, and distributed quantum sensing. The major challenge in quantum network is developing intermediate nodes that could reliably distribute entangled photons over long distances. Among other solid-state qubit platforms, vanadium doped silicon carbide has emerged as a particularly attractive candidate for quantum nodes due to its telecom range emission, mature growth and fabrication technique, and long coherence time. In this study, we spatially map vanadium defects in 3C, 4H, and 6H polytypes of SiC. We develop a confocal microscope experimental set-up by using a nano-positioning stage with piezo controller to make a raster scan of the SiC surfaces. At each point of the scan, we measure the fluorescence intensity under UV pump with a single photon detector and a counting module to locate vanadium defect. This spatial photoluminescence mapping of vanadium in SiC will enable further investigation, such as second-order autocorrelation measurement and spin dependency of optical transitions, which will validate the potential of vanadium doped silicon carbide for quantum technology applications.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Jack Deye
Academic Institution:	University of California, Los Angeles
Major:	Math of Computation
Academic Standing (Sept. 2024):	Sophmore
Future Plans (School/Career):	TBD
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, Mathematical Modeling Group
NIST Research Advisor:	Dr. Ryan M. Evans
Title of Talk:	Radial Basis Functions and Biological Field Effect Transistors

Abstract:

Biological field effect transistors (Bio-FETs) are bioelectronics that offer novel biomarker measurements and promise to broaden access to crucial medical diagnostic tests. Traditionally, measurement techniques require specialized facilities and expensive equipment; however, Bio-FETs offer rapid, accurate and cost-effective measurements in a hand-held and portable form. In these devices, chemical reactants are injected into a solution-well, where they bind to biochemical gates on the surface of the sensor, which produces an electrical signal. A mathematical model for this process takes the form of an integrodifferential equation with a kernel that is logarithmically singular. Previous numerical methods show convergence that is approximately linear. We discuss the use of Gaussian radial basis functions to develop a faster and higher order numerical method to solve this problem.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Francis Durso

Academic Institution: Johns Hopkins University | **Major:** Computer Science

Academic Standing (Sept. 2024): Masters Student

Future Plans (School/Career): Masters in Computer Science, AI Development / Consulting

NIST Laboratory, Division, and Group: Information Technology Laboratory

NIST Research Advisor: Dr. M. S. Raunak

Title of Talk: Optimizing Data Binning for Enhanced Accuracy in Classification Algorithms

Abstract:

In machine learning, there is often the need to preprocess and discretize data into a tabular form that the model expects. For example, the brightness level from images can become tabular data in circumstances when the images themselves can't be used. We can then consolidate groups of similar data values into clusters, commonly referred to as bins. The importance of how we bin data—including the number of bins and whether we bin data by bin width or by data frequency—is critical for the accuracy of the resulting algorithm. This is particularly relevant for our newly developed Combinatorial Frequency Differentiating tool, which analyzes feature value combinations to detect notable patterns between class and non-class data files. This tool requires evaluating every feature value combination under different t-way combinations (currently from 1 to 3). Depending on data sizes this can be a time-consuming process, especially when dealing with numerous close but distinct data values. Proper binning can significantly expedite this process, but it introduces the risk of losing accuracy and certainty in the results.

My research during this internship will focus on exploring and determining the most effective data binning strategies to maintain accuracy while enhancing the speed of the Combinatorial Frequency Differentiating tool. I will investigate various binning techniques, including equal-width binning, equal-frequency binning, and variable-specific binning, and analyze their impacts on the tool's performance. By applying these techniques to a series of datasets, I will measure the accuracy and efficiency of the classification outcomes. The goal is to develop guidelines and best practices for data binning that can be applied not only to our tool but also to other classification algorithms. This research aims to strike a balance between computational efficiency and statistical significance, ultimately contributing to more reliable and faster data analysis methods.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Davis Ford
Academic Institution:	Florida State University
Major:	Computer Science
Academic Standing (Sept. 2024):	Freshman (Graduate)
Future Plans (School/Career):	Graduate school
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, Mathematical Analysis and Modeling Group
NIST Research Advisor:	Michael Mascagni

Title of Talk: Speeding Up TestU01 with Threads

Abstract:

Random number generation has significant applications in various fields such as gambling/lotteries, simulations, cryptography, and video games. It is important for these random number generators to behave as if they are truly random. These are also known as pseudorandom numbers. Depending on the application, the quality or speed needed from the random number generator may differ. It then becomes important to have a standard for testing random number generators so we can measure these properties.

TestU01 is currently the most popular software library for testing random numbers. It provides several general random number generators and a myriad of tests that can be done on the library's predefined generators, user-defined generators, or number streams stored in readable files. Our main focus is the three batteries of tests known as Small Crush, Crush, and Big Crush. These tests can take anywhere from a few seconds to several hours. An important note is that none of these tests rely on another for results, so they should be able to run at the same time. What we want to do is exploit multicore processors by making these tests run in parallel with the use of threads. Doing so will greatly reduce runtime, allowing users to obtain more results in less time. We anticipate needing this data for assessing new techniques in machine learning and big data.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Shraddha Hardikar
Academic Institution:	University of California, Irvine
Major:	Computer Engineering
Academic Standing (Sept. 2024):	4th-year Undergraduate
Future Plans (School/Career):	Master's /PhD Program in EECS or Applied Math-CS
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Computer Security Division, Cryptographic Technology Group
NIST Research Advisor:	Angela Robinson
Title of Talk:	Neural-Network Based Cryptanalysis

Abstract:

With widespread use of digital electronics, cryptographic algorithms have become ubiquitous to ensure secure digital-information exchange. Cryptanalysis is an ongoing field of research that critically evaluates existing cryptosystems, identifying any vulnerabilities that may compromise security. Breakthroughs in quantum cryptanalysis, such as Peter Shor's 1991 algorithm, revealed that classical cryptosystems (RSA, Diffie-Hellman) will be vulnerable to polynomial-time attacks on quantum computers. This led to the emergence of lattice-based and code-based cryptosystems, which are considered post-quantum secure. Recently, cryptanalysis based on neural networks and machine learning has emerged as a potential attack avenue for lattice-based cryptosystems. Transformer neural networks have shown moderate success in solving the Learning with Errors problem, which is fundamental to many lattice-based cryptosystems. In this project, we aim to assess the effectiveness of transformer neural networks in solving the syndrome decoding problem, which is fundamental to code-based cryptosystems.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Jeffrey Howard
Academic Institution:	University of Chicago
Major:	Mathematics & Computer Science
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	Information Tech Laboratory, Software and Systems Division, Standards Group
NIST Research Advisor:	Jacob Collard

Title of Talk: Standards as Discourse

Abstract:

The final objective of this project is to make interfacing with standards easier and more efficient. One challenge in working with a standard is the large amount of content it covers combined with how interdependent that content can be (reused definitions, referenced procedures, related discussions or reccomendations, etc.). This means that consulting a standard to solve one narrow problem or change one aspect in a standard could involve picking out many pieces of disparate information that are sparse over the large document. Analysis of the content in standards could allow future researchers to develop tools that could illuminate these dependencies, thus standards developers and users can extract only the information they need and ignore that which they do not. In this project, we evaluate different tools that could be used to accomplish this task. These tools include symbolic parsers, machine learning based parsers, and topic modeling.

SURF Student Colloquium

NIST – Gaithersburg, MD
August 13-15, 2024

Name: Megha Jasti	
Academic Institution: Carnegie Mellon University	**Major:** Information Systems
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Complete undergraduate degree, pursue a career in the technology industry
NIST Laboratory, Division, and Group:	ITL, Computer Security Division, Secure Systems and Applications Group
NIST Research Advisor:	Gopi Katwala
Title of Talk:	Implementing m-NGAC in Oracle for Off-the-Shelf Fine-Grained Access Control

Abstract:

Enforcing access control for data stored in relational databases (RDBMSs) is an ever-evolving challenge. Traditional databases like MySQL and SQL Server offer access control through GRANT statements that manage access to objects such as tables and functions. However, these databases lack fine-grained control of individual data fields, leaving data vulnerable when accessed directly. Currently, fine-grained access control is managed in the middle-tier or front-end, which is inefficient and leaves data vulnerable.

Embedded Next Generation Access Control (m-NGAC), developed by NIST and standardized by ANSI/INCITS, addresses this issue by implementing fine-grained access control. The framework builds and retrieves access control policies that define access to sensitive data. Users query data in the tables using SQL statements and can only view information they are authorized to see based on the policies stored in m-NGAC. Embedding NGAC directly into the database achieves selective access control for clients straight off-the-shelf. With m-NGAC, users can directly query their organization's database, removing the need for access control in other tiers.

The current work aims to show the portability of NGAC by converting the MySQL implementation to Oracle, and the use case database to another database format. Each implementation was customized based on the functionality provided to optimize efficiency. After researching other databases, Oracle was used due to having better native materialized views. A website was created to test the implementation in multiple manners.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

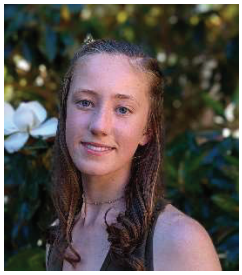
Name:	Mikhail Krepets
Academic Institution:	University of Maryland, College Park
Major:	Computer Science
Academic Standing (Sept. 2024):	Recent Graduate
Future Plans (School/Career):	Grad school at the University of Saarland, then research and/or education.
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Division 771, Mathematical Analysis and Modeling Group
NIST Research Advisor:	Professor Michael Mascagni
Title of Talk:	Walk on Spheres improvements for ZENO

Abstract:

Walk on Spheres (WoS) is a Monte Carlo algorithm which simulates Brownian motion through the use of spheres. ZENO is a program which uses the WoS algorithm to calculate various traits (such as capacitance and volume) of shapes, usually molecules.

The research task we were assigned this summer was to implement a modification to the WoS algorithm implemented in ZENO and then test whether the speed of ZENO improves or not. The modification is one that slightly over-expands the spheres in the WoS algorithm in hopes of taking less steps while sacrificing a tiny bit of accuracy.

If this modification ends up increasing the speed of ZENO without sacrificing too much accuracy, then it could be implemented in ZENO. We are also working on making this into a paper.



SURF Student Colloquium

NIST – Gaithersburg, MD
August 13-15, 2024

Name: Sydney Lee

Academic Institution: The University of Texas at Austin

Major: Applied Mathematics

Academic Standing (Sept. 2024): Sophomore

Future Plans (School/Career): Data Science

NIST Laboratory, Division, and Group: ITL, Applied and Computational Mathematics Division, Mathematical Modeling Group

NIST Research Advisor: Dr. Leroy Jia, Ph.D.

Title of Talk: Enhancing cytometer data collection with a high-speed neuromorphic camera

Abstract:

Unlike conventional cameras which capture individual frames, neuromorphic cameras possess pixels that respond independently to changes in brightness and record a continuous stream of change detection event data. In a neuromorphic camera, each event is denoted by a 0 or 1 to describe its change in polarity, a timestamp, and a coordinate to indicate the pixel's location on the camera's sensor. The information supplied by the camera can be harnessed to draw conclusions about the velocity, streamline, size, and shape of a particle moving in a flow cytometer. Our analysis is currently restricted to a single rigid bead, but our findings will enable us to draw similar conclusions about deformable particles, such as cells and droplets.

The principal investigative techniques we are employing to calibrate our camera include bias tuning, noise filtering, principal component analysis, and probability density modeling. We are adapting Prophesee's existing Python script to cycle through a series of parameter settings so that we can more efficiently collect the data supplied by a range of biases and determine the settings that optimize for sharper edges and reduced noise. In addition to bias tuning, we are also analyzing a recording using a Density-Based Spatial Clustering of Applications with Noise (DBSCAN) algorithm to create clusters that isolate the event data caused by the particle from the noise. DBSCAN illustrates the bead's streamline and provides a refined set of data that we can use to construct a kernel density estimation of the particle's density, thus allowing us to draw conclusions about the particle's diameter and shape.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: William Lee		
Academic Institution:	Montgomery College	**Major:** Computer Science
Academic Standing (Sept. 2024):	Junior	
Future Plans (School/Career):	Complete my bachelor's degree and pursue a master's degree	
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Information Access Division, Image Group	
NIST Research Advisor:	Mei Ngan	
Title of Talk:	Image restoration to improve face recognition outcomes – Does it really work (and how do we know)?	

Abstract:

The accuracy of automated face recognition has motivated its ubiquitous deployment in numerous applications, particularly in cooperative applications such as identity verification at airports or to gain access to our phones. However, there are applications where face images are collected under unconstrained environments, and the reliability of face recognition systems start to degrade. Image restoration techniques have been developed with goals of recovering an original image from a degraded one, with degradations caused by blur, distortion, compression, poor illumination, and others. While a restored face may be visually convincing (subjective), does it actually improve biometric matching outcomes? While there exists commonly used metrics that compare the effectiveness of different restoration techniques, these metrics may not meaningfully reflect its impact on biometric matching, and testing protocols are not universal. The goal of this project is the development of a standard protocol with proposed metrics and methodologies that objectively measure the performance of different image restoration techniques on biometric outcomes.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Yerim (Vicky) Lee	
Academic Institution: Wellesley College	**Major:** Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	TBD
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Information Access Division, Information Retrieval Group
NIST Research Advisor:	Ian Soboroff, Ellen Voorhees

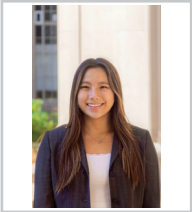
Title of Talk: Judging Large Language Models on Generating Relevance Judgments

Abstract:

Collecting accurate relevance judgments is a crucial yet labor-intensive process in information retrieval (IR) research. Traditionally, this task has relied on human annotators, which can be costly and limits the number of judgments that can be obtained. As an alternative, our research evaluates the reliability of large language models (LLMs) to generate quality relevance judgments given a query and text data.

The focus of my project is on fine-tuning LLMs on TREC datasets to assess their ability to match human-curated relevance labels. By investigating various fine-tuning techniques and model architectures, the work aims to identify the most effective LLM-based approaches for generating high-quality relevance judgments.

While recent studies have shown promising results in using LLMs for relevance judgment generation, it is important to thoroughly evaluate the robustness and reliability of these systems. Our research seeks to understand the limitations and potential biases of LLM-powered relevance judgment generation, ensuring the generated labels are of sufficient quality to support comprehensive and data-driven IR system assessments. Ultimately, by leveraging LLMs responsibly, this work aims to streamline the relevance judgment process while maintaining the robustness required for meaningful IR system assessments.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Anna Li
Academic Institution:	Massachusetts Institute of Technology
Major:	Computer Science & Economics
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Interested in Software Engineering
NIST Laboratory, Division, and Group:	ITL, Software and Systems Division, Information Systems Group
NIST Research Advisor:	Tim Blattner
Title of Talk:	Exploring the Use of Digital Twins to Generate Ground Truth for AIs

Abstract:

Creating ground truth is fundamental yet time consuming and error prone process that is required to train AI models. In particular, the task of semantic segmentation typically involves meticulously annotating datasets by classifying each pixel to distinguish between different objects or regions. In this presentation, we explore the feasibility of leveraging digital twins to expedite the creation of ground truth for AI training. By utilizing X-Ray Computed Tomography (CT) images of objects that have corresponding digital twins, we investigate methods to align these models effectively. This alignment serves as the ground truth for training AIs. We present the experimental results of objects that are manually aligned and explore the performance of AIs trained on the generated ground truths in order to streamline the training process.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Alexander Liu
Academic Institution:	Georgia Institute of Technology
Major:	Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a PhD in condensed matter physics or functional materials
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, High Performance Computing and Visualization Group
NIST Research Advisor:	Simon Su
Title of Talk:	Extending Tools for Physical Measurement in Virtual Environments in Paraview

Abstract:

The sciences rely on careful experimentation and measurement, which require esoteric reactants, complex procedures, and devices of incredible calibration to produce useful results. When such precision is required, large funding sources are too. One method to circumnavigate the cost is through modeling. Either the experiment, scenario, or measurements can be visualized in a virtual environment through Paraview, an open source software developed for 3-D datasets such as point clouds and CAD models. Multi-dimensional types of data, such as position, chemical composition, velocity, forces, and energy can be recorded, making the program well suited for scientific measurement and data analysis.

Paraview allows for a great deal of customization through custom plugins. Our aims include the following: increase the functionality of built in features such as the ruler, making it better behaved for all types of 3-D data, particularly LIDAR data; implement controlled placement of 2-D projections of 3-D data in virtual environments for better usability; and build in tools for plotting live location specific data. By working in collaboration with data from groups making position dependent measurements with real world viewable data, and drawing on use cases for physics, materials science, and engineering, further relevant improvements to the software can be made, driving a potential new avenue for scientific research.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Evan Liu
Academic Institution:	University of Maryland College Park
Major:	Computer Science
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Work in industry
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Division 775
NIST Research Advisor:	Dr. Peter Bajcsy
Title of Talk:	Measurements from event-based and frame-based cameras

Abstract:

Event-based cameras, unlike frame-based cameras, stream locations where intensities change over time instead of a fixed size stream of image frames. If there is no movement or intensity change at a microsecond time interval, the event-based camera will not stream anything. This event-based approach minimizes bandwidth requirements and, hence, latency between measured events of interest. The increased temporal resolution of event streams enables increased measurements per particle, which implies higher statistical confidence in particle tracks and, ultimately, in their particle diffusion coefficients.

The synchronization issue of event-based cameras with frame-based cameras was initially addressed by analyzing particle intensity and event polarity histograms from each data stream. The computed histograms indicated transitions between closed and opened shutters, which allowed for the automated synchronization of 15 pairs of data streams. Next, the spatial registration challenge was tackled by converting a frame-based stream into an event-based stream using an event camera emulator. A pair of synchronized event frames were used to select corresponding points. A rigid 2D transformation was applied to align the points extracted from both camera types, compensating for the differences in field of view (FOV) and enabling coherent analysis of synchronized footage. Afterwards, the generic Metavision particle tracker was used to address the particle tracking problem. Parameter optimization of the Metavision particle tracking software was undertaken using reference measurements (e.g., ruler and beads, in um/pixels) to accurately filter particles from noise and artifacts. Finally, the characterization of particle tracks was approached by quantifying the variation in bounding box sizes over the length of identified tracks. Histograms of standard deviations of bounding box areas were plotted to visualize the distributions, allowing for the definition of uncertainty metrics based on the variability within tracks.

SURF Student Colloquium

NIST – Gaithersburg, MD August 13-15, 2024

Name:	Marianne Nguyen
Academic Institution:	University of Maryland, Baltimore County
Major:	Computer Science
Academic Standing (Sept. 2024):	Freshman
Future Plans (School/Career):	Finish my Bachelor's Degree in Computer Science and pursue a Master's Degree in Bioinformatics.
NIST Laboratory, Division, and Group:	Information Technology Laboratory – Statistical Engineering Division – Statistical Design, Analysis, and Modeling Group
NIST Research Advisor:	Adam Pintar
Title of Talk:	Web App for Measurement Error Models

Abstract:

In regression analyses, measurement error models, in contrast to ordinary least squares, account for errors in both the independent and dependent variables. An important application of measurement errors models is fitting property-size relationships for nanoparticles. These relationships are important for understanding dose when lipid nanoparticles act as carriers for a vaccine or nanoplastics as carriers for toxins. To lessen the burden for experimentalists of applying measurement error models to their data, a SURF student in the 2023 program drafted a web application (app) with that goal. The app requires two files uploaded by the user: 1) a tabular data file with two columns of data, one for the independent variable and another for the paired values of the dependent variable, and 2) another tabular data file that contains only values of the independent variable, referred to as reference values. The reference values are measured by a more precise method than those in the first file. The app fits one or more measurement error models as selected by the user.

Throughout this summer (2024), I worked on refining the usability, reliability, and performance of the web app as well as developing documentation. Some new features include allowing users to choose which columns in the tabular data files contain the correct data, exposing new analysis choices such as the number of Monte Carlo replicates for uncertainty propagation, and providing users the options of saving results and graphics. For performance, when feasible, loops were replaced by vectorized NumPy functions, and calculations that are used multiple times are cached. For reliability, the app now outputs useful error messages when the data files are not in proper format, and multiple file types are now allowed such as space delimited, comma delimited, and xlsx. The documentation includes installation instructions, the expected format of the data files, and advice for selecting a measurement error model and interpreting output of the app.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Shawn Pourifarsi
Academic Institution:	University of Maryland: Baltimore County
Major:	Computer Engineering
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Finish my bachelor's degree in Computer Engineering with a focus in Cybersecurity and Electrical Systems
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, High Performance Computing & Visualization Group
NIST Research Advisor:	Dr. Simon Su
Title of Talk:	Exploring and Addressing the Limitations of Shaders in Paraview

Abstract:

Shaders are essential programs that run on the GPU of computers to calculate the appropriate amount of color and light for an object. There are a few types of shaders, but the primary ones are the vertex shader (describes attributes) and fragment shader (describes traits). These shaders are used everywhere but specifically for the High Performance Computer and Visualization Group for scientific visualization. These shaders allow for accurate and meaningful representations of data in 3D space, presenting data in an easily understandable way. Currently, the group uses ParaView, which utilizes a set of default shaders written in the OpenGL Shader Language (GLSL) from the Visualization Toolkit (VTK). The issue currently is that ParaView does not allow for easy shader replacements.

To solve this problem, we have to remove all of the default shaders ParaView uses. With ParaView's shader replacement feature and a compiled list of the default tags from VTK, we can empty out all the shaders ParaView uses allowing for easier user-developed shader code to be imported into ParaView. With the user-developed code, more realistic renderings of 3D data are possible allowing for better data visualization.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Akhilesh Reddy
Academic Institution:	Ohio State University
Major:	Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	ITL
NIST Research Advisor:	Derek Juba
Title of Talk:	Mapping Uncertainty for Image Classification

Abstract:

In any image classification network there will always be a level of uncertainty with any result that is given. The logit value (between 0 and 1) outputted by a network can represent the level of confidence that a network has in its prediction. But this alone does not give the whole picture. Network weights are set by using training data, so it is no secret that we should expect a near 100% accuracy and confidence if the training data is used for inferencing after the model is set. That confidence should logically remain high if a given image is "close" to a training image, and get lower the farther it gets away from the training data.

With this project we extensively trained a network using simple images that contained or didn't contain squares. A test set containing every possible square or non square image was run through several models, and we then examined the accuracy of the model's prediction based on image distance. Ideally these distance uncertainty values can be used to augment predictions and quantify the uncertainty of the prediction. For predictions on data that highly deviates from the training set, users will know that the network does not have high certainty on the classification, and can use this to decide whether to take action based on this information.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Joey See
Academic Institution:	Texas A&M University
Major:	Electrical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Silicon Design/Manufacture
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied Cybersecurity Division, Cybersecurity and Privacy Applications Group
NIST Research Advisor:	Nelson Hastings
Title of Talk:	Area-based Trojan Prevention for Open Source Silicon Design

Abstract:

In recent years, open source integrated circuit design tools have brought silicon design and manufacture capabilities to the general public. However, in doing so these design tools have also dragged in the security challenges involved in chip design that open source designers must now face without the time, funding, industry connections and testing equipment normally required to address these issues. Fortunately, since the majority of open source designers (hobbyist, researchers, etc.) currently do their work in the noncommercial sector, their designs are usually only subject to opportunistic attacks - simple attacks requiring little additional effort from the attacker. Few, if any, open source based designs are profitable enough to merit the resources required for a determined attack like intensive reverse engineering. Even then, in order to allow the open source silicon design movement to expand, it will need security options tailored to these opportunistic threats.

To this extent, this project examines whether an area-based hardware trojan prevention would be a viable security addition to current open source tool chains. Hardware trojans are malicious circuits inserted into chip designs by an attacker to accomplish goals like leaking information or denying service. Since simple implementations require low amounts of time and design effort, they are especially viable for use in opportunistic attacks. One way to prevent these is to ensure there is no free space on a chip to insert a trojan. This area-based method can't stop determined attackers but, if implemented correctly, we believe it could be an easy way to deter opportunistic attackers.

In order to better explore this topic, we aim to create a high ease of use area-based trojan prevention tool and analyze both its effectiveness in stopping simple trojan insertion as well as the overheads (such as parasitics and power usage) associated with the prevention method.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Faadil A. Shaikh
Academic Institution:	University Of Maryland
Major:	Computer Science/Mathematics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Persuing Masters at UMD
NIST Laboratory, Division, and Group:	Information Technology Lab, Division 771- Applied and Computational Mathematics, Mathematical Analysis and Modeling Group
NIST Research Advisor:	Dr. Micheal Mascagni
Title of Talk:	Studying the effects of using triagular meshes in ZENO on Accuracy and Speed

Abstract:

Understanding protein structures is critically important in both biochemical and medical research, and being able to analyze these structures has proven to be invaluable to these fields. As such, we strive to develop faster and more efficient methodologies to make these calculations. Currently, NIST's ZENO program uses Walk on Spheres to numerically make these calculations, which is highly dependent on closest point queries (CPQs). CPQs are trying to find the closest point from a given geometry to another geometry. These queries can be sped up by utilizing FCPW (Fastest Closest Point in the West), a library that achieves state-of-the art performance in speed for CPQ. The problem lies with the difference in native geometries, with ZENO mainly working with spheres and FCPW mainly working in triangle meshes. This summer, we studied the effects of using triangle meshes rather than spheres in ZENO in terms of accuracy and speed. We also wanted to find postprocessing we could perform to mend the gap between spheres and triangle meshes in ZENO.

SURF Student Colloquium

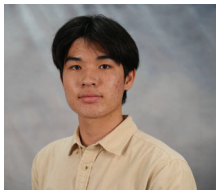
NIST – Gaithersburg, MD

August 13-15, 2024

Name: Irving Shi	
Academic Institution: University of Maryland College Park	**Major:** Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	I plan to have a career in computer science.
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, Mathematical Software Group
NIST Research Advisor:	Brian Cloteaux
Title of Talk:	Creating a Power Grid Topology Simulation

Abstract:

It has been observed that the number of connections is a power grid follow a predictable distribution. These power grid distributions behave as complex networks. The question we are interested is why do we see this distribution? Power grids are not organically developing networks, instead they are heavily engineered. Thus, there must be external factors that push power grids engineering to these distributions. We are interested in trying to determine what the roles of these factors are. Since we cannot directly experiment on power grid layout, we are creating a simulation to control for various factors. We are doing this by using machine learning techniques to simulate the placement and connection of power stations based on the surrounding population density, elevation and water area. We are basing our simulation on power grid, geographic, and population data for Europe, and then we are using a generative adversarial network approach to predict power station placement and connectivity. Once this development is completed, we will have a new tool allowing us to filter out potential factors so that we can measure their affect on power grid connectivity.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Christopher Su

Academic Institution: University of Maryland, College Park

Major: Computer Science

Academic Standing (Sept. 2024): Sophomore

Future Plans (School/Career): Master's program

NIST Laboratory, Division, and Group: Information Technology Laboratory - Power Side Channel Analysis

NIST Research Advisor: Murugiah Souppaya

Title of Talk: Power Side Channel Analysis

Abstract:

Side-channel analysis is the practice of collecting data from side channels while the target device is running and analyzing this data to extract information of interest. It caught the attention of the community of cryptography and security in general in the late 1990's when it was reported that most of the popular encryption algorithms at that time could be broken by power side-channel analysis. This completely changed the way modern cryptographic systems are designed, as a solid mathematical foundation and vigorous cryptanalysis are not sufficient, software and hardware implementation must also be considered carefully. Since then, there have been numerous studies on side-channel attacks on cryptographic systems and the corresponding mitigation methods. Today, side-channel analysis is a hot topic not only for traditional cryptography, but also for post-quantum cryptography research.

In this summer project, I am learning the basics of side-channel analysis, how side-channel attacks extract cryptographic keys, and how to evaluate a cryptographic system's resilience against side-channel analysis. This includes literature reading, lab experiments of power side-channel attacks against AES (Advanced Encryption Standard) on real devices, and simulation-based assessments of a design's security against side-channel attacks. This covers both the theory of side-channel analysis and practical skills of using equipment and software tools.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

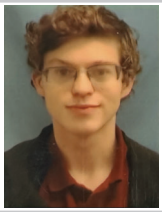
Name:	Miles Walker
Academic Institution:	Hampton University
Major:	Cybersecurity
Academic Standing (Sept. 2024):	Dean's List Sophomore with Honors
Future Plans (School/Career):	Planning to earn my Masters in Computer Science/Cybersecurity and pursue a career in the technology sector
NIST Laboratory, Division, and Group:	Information Technolgoy Laboratory, Applied Cybersecurity Division
NIST Research Advisor:	Davina Pruitt-Mentle, Ph. D.
Title of Talk:	A Case Based Human Reliability Assessment Using the Human Factors Analysis and Classification System (HFACS) Framework for the Systems Security Management Work Role

Abstract:

A common misconception is that cybersecurity attacks and incidents are primarily the product of technological errors. This is because the majority of cybersecurity work is conducted on digital devices. However, multiple recent studies have found that humans are the most prominent risk in cybersecurity, with human error accounting for more than 80% of cyber attacks. Existing cybersecurity incident reporting mechanisms often highlight only the technical aspects and aren't designed to identify human errors. The failure to address this is a missed opportunity to identify core issues and causes of cybersecurity breaches.

The purpose of this research is to identify some of the most severe supervisory errors that can occur while fulfilling the NICE Framework Program Management Work Role. To accomplish this, I will be utilizing the Human Factors Analysis and Classification (HFACS) Framework, developed by Dr. Douglas Wiegmann and Dr. Scott Shappell in the US Navy during the early 1990s. The Framework divides human factors into 4 tiers: Organizational, Supervisory, Conditions for Unsafe Acts, and Unsafe Acts. In theory, the tiers are sequential, following the "Swiss cheese model"–an error in an upper tier will trigger an error in lower tiers, and an error must occur in each tier before an accident takes place. Likewise, if any of the errors are corrected, the accident will not take place. For this project, I will be taking a closer look at the Supervisory tier of the HFACS Framework and examining the most severe errors a supervisor may encounter while fulfilling the Program Management Work Role.

Despite existing studies emphasizing their significance, many organizations have continuously failed to address human factors and their role in cybersecurity breaches. The NICE Program is committed to cybersecurity education, training, and workforce development. My hope is that these findings can be used to give organizations a better understanding of human factors in cybersecurity, which can then be applied to training programs, as well as the development of the Program Management Work Role. Supervisors properly executing the Program Management Work Role will be able to help eliminate unnecessary human errors. If implemented correctly, these findings will ultimately result in a stronger, more robust cybersecurity workforce.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Tom Wolcott

Academic Institution: University of Maryland, College Park | **Major:** Computer Science and Physics

Academic Standing (Sept. 2024): Junior

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

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

NIST Research Advisor: Barry Schneider

Title of Talk: Using Discrete Variable Representation to Solve the 1D TDSE

Abstract:

The 1D time-dependent Schrödinger equation (TDSE) is a useful tool for testing computational methods before addressing more complex problems. The problem analyzed here represents a 1D hydrogen atom under the effect of a short laser pulse. While no analytical solution exists, results on this problem provide valuable insight into how numerical methods may perform on, for example, a fully 3D hydrogen atom under similar conditions.

To compute the 1D TDSE's propagation under the laser pulse, we used a discrete variable representation. This method divides the spatial dimension into evenly spaced grid points and represents the temporal dimension as a sum of Lagrange polynomials using Gauss-Lobatto quadrature points. Consequently, solving the differential equation across space and time is transformed into solving a system of linear equations. Indexing each matrix block by the spatial points and indexing each element within a block by the temporal points results in a block-tridiagonal matrix, where each block represents the propagation over time with the off-diagonal blocks coupling neighboring points in space. The matrix's main diagonal blocks are dense, while the blocks on the off-diagonals are scalar matrices. This structure greatly reduces computational expense. Additionally, iterative methods can further speed up computation and, in some cases, enable parallelization.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Lilian Xiao
Academic Institution:	University of Pennsylvania
Major:	Computer Graphics
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Complete bachelors degree in computer science/graphics and accelerated masters in computer graphics and game technology
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Applied and Computational Mathematics Division, High Performance Computing and Visualization Group
NIST Research Advisor:	Judith Terrill
Title of Talk:	Improving Lighting in Immersive 3D Scientific Visualization

Abstract:

The development of 3D immersive visualization has enabled significant improvements in the representation and analysis of scientific data. The High Performance Computing and Visualization (HPCV) group within ITL has pioneered this technology for the scientific community; using CAVE technology, data can be visualized in 3D within an augmented or virtual reality environment, allowing researchers to step inside and navigate their data in real-time. The software implemented is ParaView, an open-source data analysis and visualization application, which builds upon the Visualization Toolkit (VTK) system and provides tools for rendering and analyzing data. However, as ParaView is not modeling software such as Blender or Autodesk Maya, the data can be visually unrealistic or flat. As visual clarity and rendering quality are essential for satisfactory visualizations, lighting is integral for developing overall context and successfully transmitting scientific information.

This project investigates the lighting tools and capabilities of ParaView, as well as methods to improve visual clarity, focus, contrast, and the ease of effective lighting. VTK supports OpenGL (GLSL) shaders, which ParaView uses to shade objects, but these default shaders do not allow for realistic and engaging lighting. By employing ParaView's Light Kit tools, we enable adding and adjusting multiple types of lighting, which can provide significantly better visual clarity alongside physically-based rendering and environmental lighting options. Additionally, this project has found raytracing with Intel OSPRay and NVIDIA OptiX to be integral for realistic lighting and improved shading.

SURF Student Colloquium

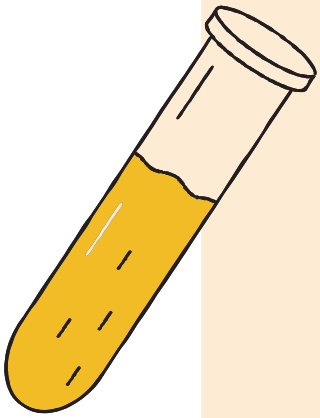
NIST – Gaithersburg, MD

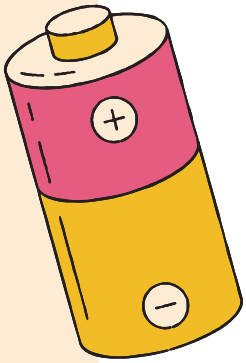
August 13-15, 2024

Name:	Andrew Zhang
Academic Institution:	Massachusetts Institute of Technology
Major:	Computer Science and Mathematics
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Pursue graduate school in computer science
NIST Laboratory, Division, and Group:	Information Technology Laboratory, Information Access Division, Multimodal Information Group
NIST Research Advisor:	Haiying Guan
Title of Talk:	Advancing Deepfake Defense: Building a Comprehensive Generative-AI Detection Dataset

Abstract:

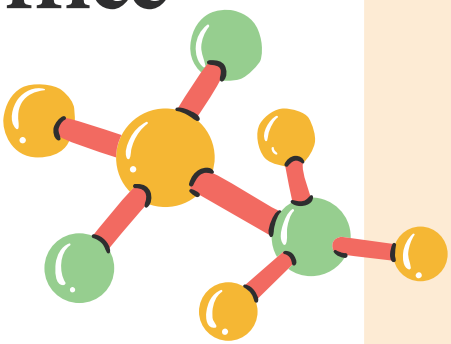
The past few years have seen a drastic rise in the accessibility and usability of high-quality generative AI. New GAN-based and diffusion-based models have allowed the general public to easily create fake images, videos, and audio, leading to the spread of misinformation, identity theft, and security risks. Thus, creating a robust algorithm to differentiate between real and fake media is vital. In this work, we first set up a state-of-the-art deepfake detection system and run it on the existing OpenMFC evaluation dataset, obtaining promising results. Then, to test the robustness and generalization capabilities of this and future deepfake detection systems, we use several state-of-the-art deepfake generation algorithms, including GAN-based and diffusion-based algorithms, to create a novel deepfake evaluation dataset. We also implement several post-processing algorithms to remove artifacts from the data and further test the robustness of the detection system. This dataset serves as a benchmark to test specific attributes of different deepfake detection algorithms, helping evaluate and improve future deepfake forensic technologies.

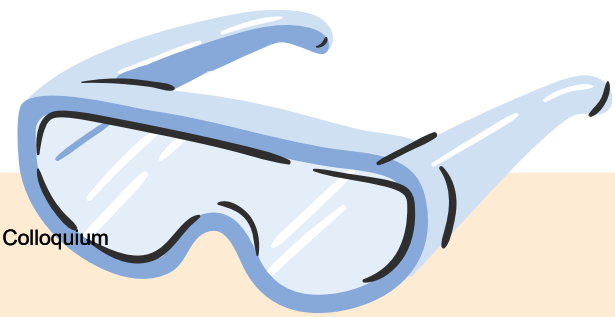




International and Academic Affairs Office & Public Affairs office

2024





Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

International and Academic Affairs (IAAO) & Public Affairs Office (PAO)

Mikelley Baptiste	Special Project - IAAO Program Engagement Resources

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Mikelley Baptiste
Academic Institution:	Spelman College
Major:	Psychology/Pre-med
Academic Standing (Sept. 2024):	Graduate
Future Plans (School/Career):	Physician/ Health Policy Advocate
NIST Laboratory, Division, and Group:	IAAO & PAO
NIST Research Advisor:	Lakesha Perry
Title of Talk:	Dissemination of Academic Affairs Programmatic information through SharePoint

Abstract:

The National Institute of Standards and Technology (NIST) is one of the foremost research facilities contributing to measurement analysis and creating standards. The International and Academic Affairs Office (IAAO) works under the director's office at NIST. The Academic Affairs Office (AO) concentrates on managing academic internship and fellowship programs. AO also attends conferences and career fairs for recruiting and outreach efforts. The academic affairs mission is to diversify the scientists and engineers that contribute to the measurement science and standards research at NIST and support the growth of a general community that comprehends the work being done. To efficiently disseminate all information regarding the academic endeavors at NIST, it is important to consolidate all the resources used by NIST mentors and associates. In coordination with the Public Affairs Office, the experiences of the Summer Undergraduate Research Fellows will be captured to further enrich the understanding of future SURF mentors and fellows while bringing more exposure to the academic opportunities at NIST. To make programmatic information easily accessible for internal NIST users, a SharePoint resource page will be created for each academic program.

Material Measurement Laboratory 2024

Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Materials Measurement Laboratory (MML)

Peter Anderson - **MML plenary speaker**	Textile Sorting Algorithms using Near Visible Infrared Spectroscopy towards Circular Economy
Sasha Menchaca	High-Speed In-Situ X-ray Imaging of Powder Particle Behavior in Laser Powder-Blown Directed Energy Deposition
Annabel Shim	The Effect of Laser Beam Shape on Material Structure in Directed Energy Deposition
Ian Fagan	Software Development for the IUPAC "Adsorption Information Format"
Austyn Nguyen	Developing a FAIR-compliant Metadata Standard for Phase Field Data using Semantic Web
Nishwanth Gudibandla	Tuning the magnetic properties of two-dimensional (2D) VxTi1-xSe2 through Alloying
Abigail Antonishek	Evaluation of NISTmAb Peptide Mapping Precision and Method Transfer
Leonardo Borchert	FE Analysis of Elastic Indentation Deformation of Layered Structures in Advanced Packaging
Arden Dombalagian	Data Acquisition and Analysis of Differential Nanocalorimetry
Joanna Li	Differential Nanocalorimetry Circuit Measurements
Jace Bell	Developing Methods to Detect Microplastics Released from Facial Scrubs
Selana Kurutan	Evaluating Separation Efficiency of Secondary Micro and Nanoplastic Controls to Improve Particle Identification and Characterization
Susannah Armstrong	Characterization of Recycled Plastic Products for Asphalt Paving Applications
Remi Mellinghoff	The Rate of Chemical Changes during Outdoor Sunlight Weathering of Polyamide Pellets
Allison Caranza	Chemical Recycling of Polyester Based Textiles
Eliana Szabo	Effects of Thermal History on Semicrystalline Morphology of Polypropylene During Fused Filament Fabrication
Caitlyn Edgar	Shear Rate Dependence of Polyolefin Blend Morphology
Nuelle Johnson	Using Time-gated (TG) Raman to Characterize Marine Plastic Pollution from Hawaii
Hayden Brandt	Characterization of the Picosecond Dynamics of Polycarbonate using Coarse-Grained Molecular Dynamics (MD) Simulations
Maya Reid	Surface Variants of the NISTmAb
Sonia Ghoshal	Removing Diffraction from X-ray Fluorescence Spectra for HfO2 Thin Film Characterization
Ben Wenig	Characterization Methods for Isotopic Trace Labeling of Cellulose Nanomaterials
Rebecca Diaz	Structure Refinement of Nucleic Acids
Preston Connors	Measurement Methods for Carbon in Cements
Maximilian Niebur	Mapping Synthesis Landscapes for Metal-Organic Frameworks for Carbon Capture
Samuel Bentz	Ceramic 3D Printing: From Slurry to Sintered Part
Charles Mann	Understanding the Role of Nitrogen Content on Performance of 17-4PH Stainless Steel
Vincent Tsai	Curved gratings for use in X-ray grating interferometry
Victoria Chazin	Evaluating the Recovery of Exogenous Viral Material Spiked into Real Collected Wastewater Samples
Elizabeth Hackley	Characterization and Correction of Measurement Biases in Microfluidic Chip-Based Resistive Pulse Sensing for Small Extracellular Vesicle Analysis
Zainab Altamimi	Investigating Drug Vehicles for Point-of-Care Drop-on-Demand Pharmaceutical Manufacturing
Olivia Agolini	Point-of-Care Pharmaceutical Manufacturing: Tailored Dosing for Personalized Medicine
Austin Vest	Quantifying the Environmental Degradation of Trace Drug Residues Using Mass Spectrometry
Samuel Chen	Impact of Preprocessing on Machine Learning Tools for HRTEM Research
Halen Solomon	Small-volume Characterization of Solutions using On-demand, Droplet-generating Microfluidics
Leonardo Buitrago	A Legal Linguistic and Evidence-based Approach to Improve BBD Webpage AI Readiness
Theresa Thomas	What's the Big Idea? Expanding Scientific Communications for MML Programs
Peter Winstel	High Throughput Calculations for Determining Liquid Properties

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Olivia Agolini
Academic Institution:	University of Virginia
Major:	Biomedical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Pursue a PhD in Biomedical Engineering
NIST Laboratory, Division, and Group:	MML, Materials Measurement Science Division, Surface and Trace Chemical Analysis Group
NIST Research Advisor:	Dr. Thomas Forbes
Title of Talk:	Point-of-Care Pharmaceutical Manufacturing: Tailored Dosing for Personalized Medicine

Abstract:

Point-of-care pharmaceutical manufacturing is a growing field aiming to shift mass-production of medications at one central location to local facilities such as pharmacies or hospitals in order to meet the specific needs of individuals. There are vast applications including creating tapered doses to reduce withdrawal symptoms when stopping a drug or developing precise doses for narrow therapeutic index drugs. While there are several advanced manufacturing technologies that might assist in this goal, we investigated the I.DOT printer, a drop-on-demand (DoD) system that efficiently dispenses specific volumes into carriers, including tablets, capsules, and oral dispersible films. This project aims to develop the measurement science and standards necessary for pharmaceutical development and aiding regulatory agencies. Quality by Design is a proactive corrective method used throughout this research to determine critical process parameters and quality attributes to investigate. The primary drug carriers developed in this project were tablets made from semisolid materials, which have a relatively low melting point and can rapidly recrystallize, making them prime candidates as a base material for 3D printing. UV-Vis spectroscopy is a non-destructive method implemented to create calibration curves to verify concentrations of samples and also to measure how the active pharmaceutical ingredient (API) interacts with the tablet material. Several drugs were studied, including Levothyroxine, a narrow therapeutic index drug, Oxycodone, an opioid, and Citalopram Hydrobromide, an antidepressant. Using the data from this project, tailored dosing of medications can be developed by implementing the I.DOT printer to dispense precise concentrations of API into the carrier to meet a patient's specific needs. This method can be used to create tapered dosing, starting from the highest dose and gradually decreasing in fine-tune increments to zero. Tapered dosing is especially applicable to opioids and antidepressants. This research is specifically important to patients outside of the typical dosage range that need personalized medication. Future work includes studying the use of this technology with nanomedicine as well.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Zainab Altamimi

Academic Institution: Gannon University | **Major:** Biomedical Engineering

Academic Standing (Sept. 2024): Senior

Future Plans (School/Career): Physician (DO) - Engineer

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

NIST Research Advisor: Thomas P. Forbes

Title of Talk: Investigating Drug Vehicles for Point-of-Care Drop-on-Demand Pharmaceutical Manufacturing

Abstract:

Successful drug development remains dependent on centralized manufacturing sites to meet the diverse therapeutic needs of patients with predefined doses and facilitate medical preparedness. Mass drug production faces challenges in transportation, storage, accommodating special dosing requirements, and meeting the goals of precision medicine to improve patient outcomes. Equipping pharmacies and patient care settings—such as hospitals, nursing homes and urgent care centers—can make personalized medicine possible and ensure effective emergency responses. These facilities can boost local healthcare quality and access through the implementation of point-of-care (POC) pharmaceutical manufacturing.

Inspired by current advancements in additive manufacturing, drug doses can be rapidly created or modified in arrays using drop-on-demand (DoD) printing. This research aspires to develop the methodology—creating the printer ink, depositing active pharmaceutical ingredients (APIs) or excipients by droplets, and producing the final delivery vehicle— using quality by design principles. NIST aims to provide the measurement science for regulatory agencies as pharmaceutical manufacturing at POC sites evolves. In addition to personalized medicine, DoD POC manufacturing of medications has potential competencies in nanomedicine (i.e. vaccines), other medical countermeasures, tapered dosages for high abuse potential drugs, and narrow therapeutic index drugs.

This study uses Immediate DoD Technology (I-DOT) for precision dispensing and quantification of target compounds. Linear calibration curves of the APIs in the presence of an excipient were created using the external standard method and UV-vis spectroscopy. Similar samples were created using the I-DOT to serve as the analytes. Data was processed using linear least squares regression to compute the measurement uncertainties. The development and characterization of at-line UV-vis to expedite the verification and quantification process is also under investigation. Further work is being done on formulating API loaded tablets and capsules, characterization of materials, and dissolution studies.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Peter Anderson
Academic Institution:	Rochester Institute of Technology
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Fourth Year
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	MML, MMSD, Security Technologies (643.10)
NIST Research Advisor:	Katarina Goodge
Title of Talk:	Textile Sorting Algorithms using Near Visible Infrared Spectroscopy towards Circular Economy

Abstract:

In the current linear economy paradigm, textiles are produced, used, and then thrown away. Due to this, especially with the rise of fast fashion, textiles are the fastest growing category of municipal solid waste. The vast majority of these textiles are discarded with unexploited value left in the materials. A circular economy strives to extract this leftover value and incorporate it back into a productive form factor. Sorting is currently a massive hurdle for achieving this recovery. Most textile recycling processes do not have a tolerance for contaminants, requiring waste streams to be sorted before recycling. With the current industry methods, fiber sorting depends on arduous manual labor and consumer-facing information tags that are commonly inaccurate or missing. To streamline this process, the textile field has looked into the near visible infrared (NIR) spectroscopy as a potential scalable sorting method.

In this work, folded swatches of various fabrics were tested using Fourier-Transform Infrared (FTIR) spectroscopy [833 nm to 2500 nm] to gather absorbance and reflectance data. Using these data, the common methods for sorting problems were analyzed. Textiles have some unique considerations, mainly that it is both a classification (fiber type) and regression (blend percent) problem. Some of the main algorithms compared are partial least squares-discriminant analysis (PLS-DA), linear discriminant analysis (LDA), a multi-layered convolutional neural network (CNN), linear regression, and partial least squares regression (PLS). For the classification methods, metrics such as F-score were compared. Meanwhile, for regression methods, metrics such as the mean squared error (MSE) were compared. Using the various metrics, the optimal model for our data set will be proposed.

SURF Student Colloquium

NIST – Gaithersburg, MD

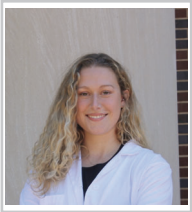
August 13-15, 2024

Name:	Abigail Antonishek
Academic Institution:	Purdue University
Major:	Chemical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Work as an associate scientist for a biopharmaceutical company that specializes in metabolic diseases.
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Biomolecular Measurement Division, Bioanalytical Science Group
NIST Research Advisor:	Trina Mouchahoir
Title of Talk:	Evaluation of NISTmAb Peptide Mapping Precision and Method Transfer

Abstract:

The NISTmAb monoclonal antibody is perhaps NIST's most "popular" reference material used by the biopharmaceutical industry. NISTmAb is representative of the biggest class of protein therapeutics on the market and has been used by companies worldwide to advance the development of new analytical and measurement capabilities applicable to antibody drug characterization and quality control. To ensure the quality of the reference material itself, NIST scientists must regularly evaluate samples for signs of degradation. The reproducibility of sample preparation and analytical methods used to monitor NISTmAb quality must be well understood so that any year-to-year variations that result from degradation may be distinguished from those caused by inherent method variation. There were three main objectives of this project: to establish an automated tryptic digestion protocol, to compare the variability between tryptic digestion of NISTmAb samples prepared for peptide mapping via standardized manual versus automated protocol, and to evaluate peptide mapping precision.

The standardized manual digestion protocol was conducted by two separate analysts to evaluate the intermediate precision of manual sample preparation. The automated protocol was executed by a Hamilton Microlab STAR Liquid Handler. Samples on the Microlab were digested using buffers made by two separate analysts to evaluate the intermediate precision of automated sample preparation. The repeatability of sample preparation was evaluated by digesting three samples at the same time on three separate days. Samples were analyzed by liquid chromatography-mass spectrometry (LC-MS) analytical techniques and the repeatability of the LC-MS was determined by injecting each sample three times in a row on three different days. The results of these experiments will be used to set quantitative specifications for monitoring the stability of the NISTmAb reference material.



SURF Student Colloquium

NIST – Waimanalo, HI

August 13-15, 2024

Name: Susannah Armstrong

Academic Institution: Davidson College | **Major:** Chemistry

Academic Standing (Sept. 2024): Graduated

Future Plans (School/Career): Pursue a graduate degree in environmentally focused chemistry.

NIST Laboratory, Division, and Group: Material Measurement Laboratory, Chemical Sciences Division, Biochemical and Exposure Sciences Group

NIST Research Advisor: Dr. Jennifer Lynch

Title of Talk: Characterization of Recycled Plastic Products for Asphalt Paving Applications

Abstract:

As the ocean plastic waste crisis grows, there is exceeding pressure to develop sustainable methods for plastic recycling. In Hawaii, an estimated 52 metric tons of plastic-based derelict fishing gear (DFG), such as fishing nets, reach the shore each year. As a sustainable solution, the Hawaii Department of Transportation (HDOT) is exploring ways to recycle DFG and other plastic waste into local infrastructure. At the Center for Marine Debris Research (CMDR) we have partnered with HDOT to test recycled plastic products for asphalt paving applications. Here we characterize two recycled plastic products that have been incorporated into a local asphalt road. The waste streams used to manufacture these recycled plastic products include high-density polyethylene (HDPE) DFG nets and HDPE post-consumer waste, both collected around Hawaii. Using microscopy, samples of each product were separated manually into particle groups based on visible similarity, i.e. shape and color. Particle count and mass was documented for each group. Material identification and particle size distribution for each group will be identified using micro-Fourier transform infrared spectroscopy (uFTIR). Polymer identity will be confirmed using attenuated total reflectance-Fourier transform infrared spectroscopy (ATR-FTIR) and differential scanning calorimetry (DSC). Lastly, double shot pyrolysis-gas chromatography/mass spectrometry (py-GC/MS) will be performed on the un-separated samples to provide additional characterization of chemical additives and polymer mass fraction. Our complete characterization will provide data on the composition of each product by polymer identity, particle count and mass, size distribution, chemical additive presence, and consistency of product between batches and sampling styles. While there has been much research on the use of recycled plastics in roads, it is lacking but essential for ongoing research to properly characterize the composition of the recycled plastic products used. Initial characterization also sets the groundwork for CMDR's future studies on the leaching of microplastics and additives from recycled roads, which is of great interest and consideration.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Jace Bell
Academic Institution:	University of Northern Iowa
Major:	Environmental Science and Biology
Academic Standing (Sept. 2024):	First-year graduate student at Oregon State University
Future Plans (School/Career):	M.S. in Marine Resource Management at Oregon State University / Career in ocean pollution policy
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Materials Measurement Science Division, Nano Materials Group
NIST Research Advisor:	Diana L. Ortiz-Montalvo, Ph.D.
Title of Talk:	Developing methods to detect microplastics released from facial scrubs

Abstract:

Microplastic and nanoplastic (MNP) particles are being increasingly recognized and scrutinized by consumers, the media, and competing corporations due to the negative effects they may pose to human health and the environment. MNPs are plastic particles less than 5 mm in size that can either be directly released into the environment as primary MNPs or are broken-down fragments of larger pieces of plastic referred to as secondary MNPs. MNPs have been found in personal care products, such as facial scrubs and cleansers, which are then discharged into the water treatment system or directly into the environment. The recent detection of spherical microplastics (MPs) at a materials recovery facility motivated the focus of this summer research project. The spherical nature of these MPs signaled that they may be primary MNPs, potentially from consumer products, like facial exfoliating cleansers that may contain MNP beads. Beads made from artificial and natural materials such as aluminum oxide, polyethylene beads, sodium tetraborate granules, as well as ground fruit pits are added to facial cleansers to mechanically exfoliate skin cells on a person's face and produce softer skin. Numerous facial cleanser products from large national cosmetic brands were identified as containing these microbeads ranging in size from 60 µm to 800 µm at wastewater treatment facilities.

This project seeks to establish a method for detecting particles released from consumer products and accurately identifying if those particles are MNPs. Fourteen facial exfoliating cleanser products from various large cosmetic brands were vacuum filtered with ultrapure water onto Nucleopore membrane filters with 14.0 µm diameter pores. The filtered particle samples were then examined and imaged using a Leica WILD M10 stereomicroscope and a Leica optical microscope in bright-field and dark-field mode. The captured images were used to record information on the color and shape of the filtered particles and to measure particle size by doing post-processing with ImageJ. Preliminary results show that several of

SURF Student Colloquium

NIST – Gaithersburg, MD

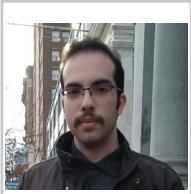
August 13-15, 2024

Name:	Samuel Bentz
Academic Institution:	University of Maryland College Park
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Considering grad school. Interested in careers in robotics, 3D printing and control systems.
NIST Laboratory, Division, and Group:	Materials Measurement Laboratory, Materials Measurement Science, Materials Structure and Data
NIST Research Advisor:	Dr. Lynnora Grant and Dr. Russell Maier
Title of Talk:	Ceramic 3D Printing: From Slurry to Sintered Part

Abstract:

Various industries including aerospace, refractory, and chemical processing require materials that are resilient in extreme conditions. Ceramics are often used to meet these demands as they have high hardness, high heat resistance and excellent chemical resistance. However, the same mechanical properties that make ceramics so strong also make them difficult to process using traditional subtractive techniques. Additive manufacturing (3D printing) ceramics opens the door to forming complex geometries and making smaller production quantities more economical. Even so, unique challenges facing ceramic 3D printing such as rough surface quality, delamination between layers, undesirable porosity, and warping during post processing have slowed commercial adoption of the technique. These defects occur throughout all stages of the 3D printing process and can be addressed through first understanding the interactions between feedstock, print parameters, and post processing conditions.

Many ceramic 3D printing processes rely on a slurry-based feedstock. Thermogravimetric analysis (TGA) and scanning electron microscopy (SEM) was used to validate the binder burnout process and analyze the morphology of particles within the slurry. During printing via direct ink write, the print speed, layer height, line width, and infill pattern were varied to understand the effect of these parameters on print quality. Samples were often observed to warp during drying and we explored using different substrates to mitigate this defect. 4-point bend testing was conducted on ceramic samples with seeded pore defects to understand the effect of defects on the mechanical properties of the final part. These investigations provided guidance on how to produce parts with fewer defects.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Leonardo Borchert		
Academic Institution:	The George Washington University	**Major:** Aerospace Engineering
Academic Standing (Sept. 2024):	Junior	
Future Plans (School/Career):	Get a PHD in Aerospace Engineering & design particle propulsion systems for air and spacecrafts.	
NIST Laboratory, Division, and Group:	Materials Measurement Lab., Div. 643, Nanomechanical Properties Group	
NIST Research Advisor:	Gheorghe Stan & Yvonne B. Gerbig	
Title of Talk:	FE Analysis of Elastic Indentation Deformation of Layered Structures in Advanced Packaging	

Abstract:

The ability to measure and analyze material properties at the nano- to micro-scale plays an important role in the development of chips in the semiconductor industry. Although some properties like elasticity are well understood at the macroscale, nanoscale elastic properties can undergo substantial alterations in multilayered architecture chips due to scale and processing effects. Attempts to solve more complex advanced packaging structures that are composed of different materials are analytically infeasible. Moreover, solving them empirically leads to highly specific formulas. The preferred solution for industry is a comprehensive method that can simulate the mechanical behavior of any chip structure. For structures made of dielectric/metal layers on silicon substrates, nano-indentation is the method commonly used to determine the elastic modulus of the layers. To tackle the complexity of the required measurement analysis, a numerical modeling in ABAQUS, a finite element analysis (FEA) software, was created to be able to simulate the contact mechanics of nano-indentation measurements. Several materials of various Young's moduli and Poisson ratios were tested to check how FEA compares against the well-known analytical Hertz model, and to understand how those characteristics change the output of the simulated results. These tests were also run to compare the accuracy of the simulation compared to the theoretical equations and actual experimental data. Furthermore, once an acceptable degree of accuracy was achieved, the scope was expanded to analyze layered systems. This was done by simulating each layer individually and then in its packaged form to compare how different materials behave and contribute to the overall force-distance response of nano-indentation measurements performed on the package. In support of a CHIPS R&D project, this is the first step towards designing a core framework to easily simulate and analyze nano- and micro-scale mechanical tests on advanced packaging structures and will eventually enable the semiconductor industry to quickly analyze chip integrity.

SURF Student Colloquium

NIST – Gaithersburg, MD

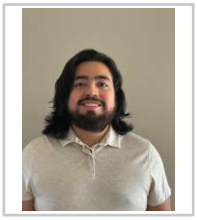
August 13-15, 2024

Name: Hayden Brandt	
Academic Institution: Clarkson University	**Major:** Physics
Academic Standing (Sept. 2024):	First-year Graduate Student
Future Plans (School/Career):	Complete my Ph.D. at the University of Oregon
NIST Laboratory, Division, and Group:	Materials Measurement Lab, Division 642, Functional Polymers Group
NIST Research Advisor:	Dr. Frederick R. Phelan Jr.
Title of Talk:	Characterization of the Picosecond Dynamics of Polycarbonate using Coarse-Grained Molecular Dynamics (MD) Simulations

Abstract:

Polycarbonate (PC) is a polymer noted for its high mechanical toughness in the bulk, but embrittles when used in applications such as thin films or analogously composite systems. The toughness of polycarbonate is known to increase with entanglement density, which increases with polymer chain length and molecular weight (MW). The toughness of PC has been shown to be characterized by the anharmonicity in the Debye-Waller Factor (DWF), which is related to the atomic mean-square displacements (MSDs) in the polymer at short timescales. The DWF can be studied experimentally with neutron scattering as well as computationally through molecular dynamics (MD) calculations. Previous work in our Group at NIST used all-atom (AA) MD simulations to explore the picosecond dynamics of polycarbonate, but this approach is impractical for long polymers with high entanglement density.

In this project, we employ a coarse-grain (CG) model parametrized for polycarbonate to study the DWF as a function of increasing entanglement density. Our CG model uses a Kremer-Grest style force-field parametrized to match the Kuhn length, stiffness, and entanglement density of commercial polycarbonate. In the first part of our simulation workflow, we build and equilibrate a number of polymer melt systems of increasing chain length at high temperature, then identify the entanglement crossover MW from the change in slope of the long-time chain diffusivity vs. polymer chain size trend. Thereafter, we run cooling simulations for each equilibrated system from the hot melt state to below the glass-transition temperature and measure the dynamics at several intermediate state points and also use this data to measure the glass transition temperature (T_g) for each system. The intermediate state-points are simulated with the aim of determining how the DWF changes during cooling for systems of varying entanglement density and qualitatively compare with trends in QENS measurements conducted in the Composites Project of the Functional Polymers Group.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Leonardo Buitrago, Vaishnavi Banda, Aprameya Seshachar

Academic Institution: University of Maryland | **Major:** Biocomputational Engineering

Academic Standing (Sept. 2024): Graduate(3.54 GPA)

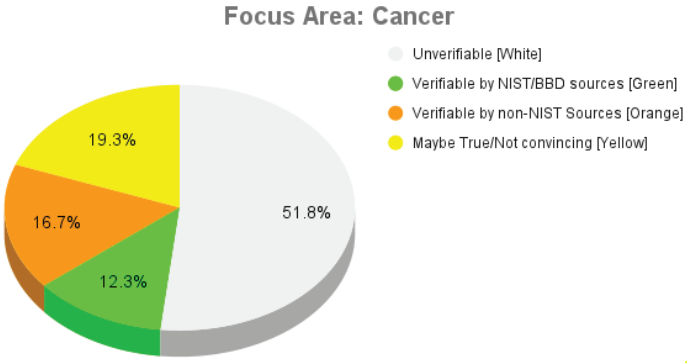
Future Plans (School/Career):	Graduate School (master's in biomedical engineering) or career in Bioinformatics/Data Science
NIST Laboratory, Division, and Group:	Materials and Measurements Laboratory, Biosciences and Biomaterials Division, Cell Systems Science Group.
NIST Research Advisor:	T.N. Bhat Ph.D
Title of Talk:	A legal linguistic and evidence-based approach to improve BBD webpage AI readiness.

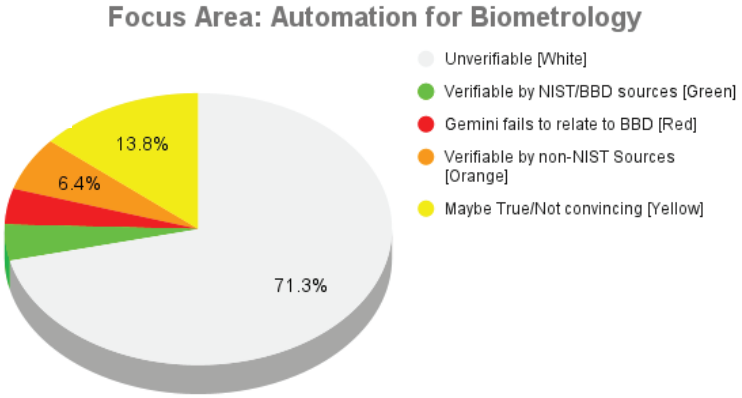
Abstract:

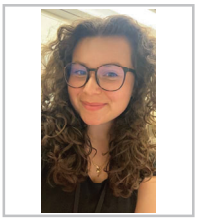
Large Language Models (LLMs) like Google Gemini are transforming human-computer interaction. This project investigates the effectiveness of Gemini in answering questions about the National Institute of Standards and Technology's (NIST) Biosciences and Biomaterials Division (BBD). We evaluate Gemini's responses, identifying potential errors due to missing information or misinformation. Our analysis utilizes a color-coded system to categorize answer quality for our 10 questions focused on each of our 9 focus areas, two of which are shown below:

- **White**: Unverifiable data not found on Google or NIST/BBD websites.
- **Green**: Accurate answer with source cited from NIST/BBD main pages.
- **Orange**: Accurate answer with source cited from external websites.
- **Yellow**: Google found content that is related to the statement but may not be accurate to the question asked.
- **Red**: Critical error; fails to connect the BBD to the user's query.

This evaluation may suggest ways to improve Gemini's responses through targeted data implementation to the BBD webpage.







SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

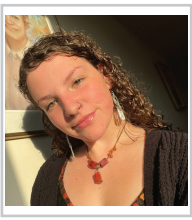
Name:	Allison Carranza
Academic Institution:	West Virginia University
Major:	Forensic Chemistry
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a PhD in Chemistry
NIST Laboratory, Division, and Group:	Material Measurement Laboratory
NIST Research Advisor:	Charlotte Wentz
Title of Talk:	Chemical Recycling of Polyester Based Textiles

Abstract:

Global textile consumption leads to increased CO2 emissions, landfill overflow, and water pollution. Although there are a wide variety of technologies for recycling textiles such as mechanical, chemical, thermomechanical, and biochemical processes, major challenges in each category persist and hinder the scalability, applicability, and practicality of these methodologies. More specifically, fabric blends with multi-material compositions make these recycling processes difficult.

This project uses chemical recycling via alkaline hydrolysis to understand the impact of mixed fiber blends, such as polyester-cotton-lycra-nylon. We also probe how the reaction conditions impact the cotton component and the terephthalic acid (TPA) yield, which comes from the depolymerization of PET. Thus far our findings indicate that the cotton maintains high quality properties. No functionality changes are observed by Fourier transform infrared (FTIR) spectroscopy and thermogravimetric analysis (TGA). However, a slight change in tenacity of single fibers through single fiber tensile testing have been noted. Understanding the bulk strength of these fibers plays a crucial role in determining their reusability and applications.

As this large scope project develops into post-consumer samples such as dyes, T-shirt graphics, different compositions of polyester (zippers, pellets, and films), we utilize trace analysis methods such as pyrolysis-gas chromatography- mass spectrometry (Py-GC-MS) and nuclear magnetic resonance (NMR) to assess the purity of the TPA produced. Another aspect we have begun to analyze is the behavior of core-spun lycra compared to non-core-spun counterparts. More specifically, a clear negative impact on TPA yield has been noted in the post-consumer samples. This effect is being further probed during this project. Ultimately, our findings highlight the significant factors that affect the chemical recycling of polyester based textile composites including dyes, graphic designs, and construct changes.



SURF Student Colloquium

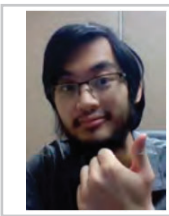
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Victoria Chazin
Academic Institution:	St. Marys College of Maryland
Major:	Biology and Art
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Further my education in a graduate degree, travel the world furthering my research experience
NIST Laboratory, Division, and Group:	MML, Division 644, Group 3
NIST Research Advisor:	Alshae Logan
Title of Talk:	Evaluating the Recovery of Exogenous Viral Material Spiked into Real Collected Wastewater Samples

Abstract:

Wastewater surveillance is a crucial tool for pathogen detection and environmental monitoring worldwide. The COVID 19 pandemic has highlighted its significance in providing early warnings of disease outbreaks through the detection of viral genetic fragments in wastewater. This study focuses on quantifying two RNA viruses non enveloped ma mmalian orthoreovirus type 1 (strain Lang) and enveloped human respiratory syncytial virus (strain A2) in synthetic and real wastewater samples. Using membrane filtration with electronegative HA membranes of varying pore sizes (0.22, and 0.60 μm), we will analyze viral concentrations across different sample types, including Complex Organic Particulate Artificial Sewage (COPAS), ASTM, and COPAS + ASTM synthetic wastewater, as well as two real wastewater samples and controls. We will be looking at the differe nces in acidification of the membranes vs non acidified membranes to determine if there is any significant difference relating to viral recovery. We will be doing nucleic acid extraction using a Zymo kit and quantification through digital droplet PCR (ddPCR). Our findings will help highlight the critical need for standardized laboratory methods and rigorous QA/QC measures to ensure reliable data and add to the current literature surrounding wastewater management. Our study also contributes to the ongoing de velopment of standardized synthetic wastewater for broad laboratory applications. We hypothesize that membrane pore size significantly affects virus recovery rates, and that acidification will not result in higher viral recovery rates of either organism . T his experiment reflects the challenges in standardizing wastewater surveillance protocols and highlights the importance of method validation and robust QA/QC protocols to minimize biases, contamination, and matrix effects, thereby enhancing the efficacy of wastewater surveillance as a public health tool.



SURF Student Colloquium

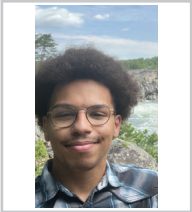
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Samuel Chen
Academic Institution:	University of Maryland
Major:	Materials Science and Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School, Green Energy Technologies
NIST Laboratory, Division, and Group:	Materials Measurement Laboratory, Materials Science and Engineering Division, Functional Nanostructured Materials Group
NIST Research Advisor:	Dr. David Yang
Title of Talk:	Impact of Preprocessing on Machine Learning Tools for HRTEM Research

Abstract:

High-resolution transmission electron microscopy (HRTEM) is a powerful imaging technique across various disciplines. It has found an impactful role in materials science because it allows researchers to characterize material structures down to the atomic scale. This role has only become more impactful as these techniques' temporal and spatial resolutions continue to improve, resulting in ever-increasing amounts of high-quality data. Unfortunately, data processing and analytical methods cannot match the relative throughput of data generation while maintaining accuracy, so much of the power of HRTEM goes to waste. The problem of data overabundance is not a unique issue in the modern age, and to address this matter, many disciplines have been increasingly turning to machine learning to develop the necessary tools. This also applies to materials scientists, who have shown that when applied to HRTEM image analysis, machine-learning computer vision tools outperform traditional alternatives. However, these models still struggle with the tradeoff between accuracy and generalizability, and it remains to be understood precisely how the myriad of parameters involved in both the training and implementation processes affect the final performance of a model. To help address this issue, this project aims to create an array of HRTEM image analysis models for segmentation, orientation detection, and atomic column measurement if time permits. These models will be made by tailoring related models from literature and modifying the preprocessing steps applied to the relevant data before they are fed into these models. These models will then be used to treat data obtained from various sampling conditions, which will shed further light on how preprocessing impacts accuracy and generalizability.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Preston Connors
Academic Institution:	Ohio Universtiy
Major:	Applied Mathematics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	I plan to pursue an M.S in environmental chemistry or atmospheric science.
NIST Laboratory, Division, and Group:	Materials Measurement Lab, Inorganic sciences division,
NIST Research Advisor:	Brian Lang
Title of Talk:	Measurement Methods for Carbon in Cements

Abstract:

Methods of carbon sequestration are integral solutions to climate change. Globally, the manufacturing process for cements produces roughly 9% of all anthropogenic carbon emissions annually. Thus, there has been an increased focus on how to minimize carbon emissions during the manufacturing process for cements. Consequently, new types of cements which harden using CO2 and emit less CO2 during production as well as processes to accelerate absorption of CO2 in established Portland cements are being studied.

The goal of this project is to provide supporting data for an ASTM test method for measurement of carbon in cements and concretes using combustion analysis. Thermogravimetric analysis (TGA) will also be used to support and better understand the combustion measurements. Combustion analysis works by combusting a sample in an oxygen atmosphere and measuring the amount of carbon dioxide released. For combustion, biases exist due to the potential for sample loss during combustion or incomplete combustion. Measurements to be done will establish reliable sample preparation methods and instrument operating parameters, protocols to maximize sample size and a procedure to account for the interference of organic carbon when measuring mineralized CO2. Thermogravimetric analysis works by heating a sample in a furnace while measuring mass as a function of temperature. Mass changes occur during heating for several reasons including dehydration and molecular decomposition. CO2 is lost when carbonates in cements thermally decompose. The CO2 content is determined by the mass loss over the range of 550 °C to 950 °C. TGA bias exist due to the potential for multiple decomposition reactions to occur over the same temperature range or variations in heating profiles. This ASTM test method will support measurements of CO2 uptake and sequestration in concretes and component materials which underpin product labeling and provide confidence in various CO2 sequestration initiatives using cements and concretes to sequester CO2.

SURF Student Colloquium

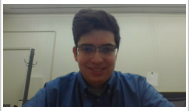
NIST – Gaithersburg, MD

August 13-15, 2024

Name: Rebeca Diaz Ventura	
Academic Institution: Stony Brook University	**Major:** Chemistry
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	MML/645.03
NIST Research Advisor:	Christina Bergonzo
Title of Talk:	Structure Refinement of Nucleic Acids

Abstract:

The importance of structure refinement in nucleic acids has led to better understanding of biological processes, in turn leading to improvement in drug design. Molecular dynamics (MD) has taken part in describing RNA structure. The addition of NMR restraints guide the structural calculations to guarantee the models are in agreement with experimental NMR data. Understanding how to apply these NMR restraints to different types of RNA structures can be difficult because not all RNA behaves the same way in different environments, and custom refinement may be needed. The use of NMR refinement may be an iterative process that requires computational optimization. Taking these variables into account, we developed a tutorial to guide users throughout the process of NMR refinement containing a detailed, comprehensive format that consists of protocols and examples on setting up and running NMR refinement using AMBER. We describe the use of a total of seven types NMR restraints in our work: Nuclear Overhauser Effect (NOE) restraints, which offer distance information between atoms; dihedral angle restraints, which provide insights into the rotation around bonds; sugar pucker restraints, which defines the ribose or deoxyribose pseudo-rotation dihedral conformation in nucleic acids; Watson-Crick restraints for base pairing; planarity restraints to maintain a planar surface between the aromatic rings; general dihedral restraints to regulate torsion angles in the backbone and side chains; and finally residual dipolar couplings (RDCs) restraints that provide information about the orientation of bonds relative to an external magnetic field. We examine the effect of NMR restraints by cross-validation using single-point-calculations.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Arden Dombalagian		
Academic Institution:	Georgetown University	**Major:** Physics
Academic Standing (Sept. 2024):	Senior	
Future Plans (School/Career):	Graduate School, PhD in Physics, Experimental Researcher in a Lab	
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Material Measurement Science Division, Nanomechanical Properties Group	
NIST Research Advisor:	Dr. Feng Yi	
Title of Talk:	Data Acquisition and Analysis of Differential Nanocalorimetry	

Abstract:

Nanocalorimetry is a chip-based thermal analysis technique used to measure thermal properties of small scale materials at fast heating and cooling rates. A nanocalorimeter sensor consists of a suspended silicon nitride membrane reduce the thermal mass, a platinum thin film which functions as a heater and temperature sensor, and a silicon wafer to support the membrane and heater. To improve the measurement sensitivity further, a differential nanocalorimetry circuit is created, in which a sample sensor with the analyzed material is in a parallel circuit with a control sensor. The project is to create a LabVIEW program to measure the voltage difference measured between the sensors in the circuit to calculate the heat capacity of the material. The goal for this project is to test a differential nancalorimetry circuit with another SURF student in the group using the LabVIEW program to measure thermal properties of nanoscale materials.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Caitlyn Edgar
Academic Institution:	University of Delaware
Major:	Materials Science and Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	4+1 Masters in Materials Science and Engineering, then industry
NIST Laboratory, Division, and Group:	MML, Materials Science and Engineering Division, Polymers Processing Group
NIST Research Advisor:	Dr. McKenzie Coughlin
Title of Talk:	Shear rate dependence of polyolefin blend morphology

Abstract:

While other countries have increased recycling rates to 18% of plastic waste as of 2014, the U.S. has stayed relatively constant at 9% recycled plastics since 2012. As the world moves away from dependence on fossil fuels and plastic pollution wreaks havoc on ecosystems, the United States recycling system must be streamlined and made more economically favorable. Polyethylene (PE) and polypropylene (PP) are the two most common consumer plastics in the waste stream, but with current sorting methods, they cannot be properly separated due to their similar densities. Rather than develop more costly sorting methods, one solution to this issue is to use PE and PP in the blended state to create recycled plastic packaging. However, the polymers are immiscible at all concentrations, which leads to poor mechanical properties of their blends. A greater understanding of the reprocessing behavior of PE/PP blends may allow for improvements in mechanical properties and as a result, greater feasibility of their combined recycling.

The most common methods to process consumer plastics are injection molding and blow molding, which both involve extensive shear forces. This study focuses on the effects of shear rate on the morphology of polyethylene/polypropylene blends, namely the shape of the dispersed phase droplets. High density polyethylene (HDPE) and isotactic polypropylene (iPP) were blended at percentages of 70% and 30% respectively into a filament using a twin screw extruder, then sheared during cooling in a Linkam shear cell at 140 °C for 12 s at shear rates ranging from 0 to 31.62 s-1. Samples were then cryofractured under nitrogen, and the fracture surfaces imaged in a JEOL-7800F scanning electron microscope. With increased shear rate, the spherical droplets are expected to undergo increased elongation.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name: Ian Fagan		
Academic Institution: University of Pittsburgh	**Major:** Chemical Engineering	
Academic Standing (Sept. 2024):	Junior	
Future Plans (School/Career):	Graduate School	
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Chemical Sciences Division, Chemical Informatics Group	
NIST Research Advisor:	Daniel Siderius	
Title of Talk:	Software Development for the IUPAC "Adsorption Information Format"	

Abstract:

Adsorption technology is an important tool to utilize and develop to increase energy efficiency in some of the world's most energy intensive fields. Almost 16% of total U.S. energy consumption is devoted to thermal separation of chemicals alone. When applied correctly, chemical separations using adsorption techniques allow for much more thermodynamically favorable separations, possibly reducing energy consumption by up to 90%. This inherent efficiency could greatly reduce the amount of energy needed for critical but energy demanding sectors like greenhouse gas capture, high purity gas production, and rare earth metal separations.

To facilitate the growth of adsorption technology, a new documentary standard- Adsorption Information File (.AIF), is being created to ensure access to accurate and reusable data for adsorption and desorption measurements. Supported by the International Union of Pure and Applied Chemistry (IUPAC), NIST personnel and collaborators all around the world have been working to develop the AIF format since the project's founding in 2021. The AIF format is designed for structured data, encoding a dictionary of key/value pairs that describe isotherm data and measurements using standardized vocabulary. Similar formats have already been used to establish field standards such as the CIF file format, used worldwide for data storage and transfer in the field of crystallography.

Currently, isotherms are often only published in a graphical format. This creates a need to manually digitize isotherms due to lack of easy access to the original data. Manually digitizing graphs is time consuming and leads to loss in data fidelity as users introduce slight errors by imperfectly tracing points on a graph. The goal of this project is to create a downloadable program where users can input their data flexibly and get a standardized output returned. With easy access to both metadata and graphical data in

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sonia Ghoshal
Academic Institution:	Princeton University
Major:	Electrical and Computer Engineering
Academic Standing (Sept. 2024):	Rising junior
Future Plans (School/Career):	Pursue a PhD in materials science or energy systems
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Materials Measurement Science Division, Microscopy and Microanalysis Research Group
NIST Research Advisor:	Dr. Donald Windover
Title of Talk:	Removing Diffraction from X-ray Fluorescence Spectra for HfO2 Thin Film Characterization

Abstract:

Field-effect transistors, the building blocks of electronic devices, each require a thin film of insulating material, known as a gate dielectric, to control the flow of current. Although SiO2 historically has been the most widely used gate dielectric, alternative gate dielectric materials more suitable for nanoscale devices, such as HfO2, have been employed as SiO2 substitutes for these increasingly smaller and higher performance computing devices.

In this study, we attempt to characterize the quality of HfO2 nanofilm samples deposited on Si substrates using micro-X-ray fluorescence (mXRF). An mXRF machine excites a sample with an X-ray beam, causing each of the elements within that sample to emit X-rays with characteristic energies. By analyzing the emitted spectra from the sample, we can determine the elements present and their respective quantities. However, complications may occur if the sample contains a crystalline structure. The crystal lattice structure acts as a 3D diffraction grating, causing photons to scatter. The scattered photons, collected at the same time as the emitted spectra from the sample, appear on the recorded spectra as diffraction peaks, at times overlapping or engulfing the emitted spectra of the sample. We observe this phenomenon with our HfO2 samples; in this case, the crystal lattice structure of the thick underlying Si substrate generates diffraction peaks, swamping the weaker fluorescence of the nanoscale Hf film.

Our primary objective in this study is to eliminate these diffraction peaks through a variety of methods: 1) applying thin metallic filters to the primary x-ray beam, 2) rotating the orientation of the HfO2 samples, and 3) employing m-XRF analysis software packages to computationally snip out diffraction peaks. By removing these diffraction peaks, we will be able to more accurately assess the compositions and qualities of the HfO2 samples for semiconductor chip manufacturers.

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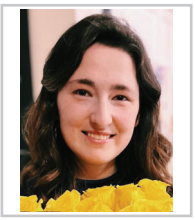
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Nishwanth Gudibandla
Academic Institution:	University of Maryland, Baltimore County
Major:	Physics & Computer Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Attend Graduate School for a Doctorate in Physics
NIST Laboratory, Division, and Group:	Materials Measurement Lab, Material Science & Engineering Division, Thermodynamics & Kinetics Group
NIST Research Advisor:	Daniel Wines
Title of Talk:	Tuning the magnetic properties of two-dimensional (2D) VxTi1-xSe2 through alloying

Abstract:

Monolayer transition metal dichalcogenides (TMDs) are a popular class of two-dimensional (2D) materials. 2D TMDs can exhibit electronic and magnetic properties suited for a variety of technological applications, such as spintronics. VSe2 is a TMD that exhibits strong ferromagnetism, with a predicted Curie temperature above 200 K. Additionally, this material possesses a competing charge density wave (CDW) phase, which adds a degree of complexity to understanding the interplay between various magnetic states. In our prior computational work using Density Functional Theory (DFT), the magnetic properties of 2D VSe2 were found to be highly tunable with strain. Specifically, the stability of the ferromagnetic state was found to be enhanced with small amounts of positive biaxial strain. Monolayer TiSe2 is another TMD that possesses a larger in-plane lattice constant than VSe2. We propose that chemical substitution of V with Ti will induce this desired strain, and thus increase the stability of the ferromagnetic state in monolayer VSe2. Taking a computational approach, we constructed a workflow to couple DFT calculations and Cluster Expansion (using the JARVIS-tools and icet software packages) to automate the generation, analysis, and prediction of the energetic stability and electronic and magnetic properties of these alloy compounds. These calculations will serve as high-quality reference data that can be utilized by experimentalists who wish to characterize VxTi1-xSe2 for applications in spintronics. In addition, this workflow can be used in future work for high-throughput analysis of binary alloys.



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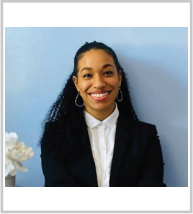
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Elizabeth Hackley
Academic Institution:	Gettysburg College
Major:	Biochemistry and Molecular Biology
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue graduate school, and eventually post-graduate research in the biochemical sciences.
NIST Laboratory, Division, and Group:	Materials Measurement Laboratory, Biosystems and Biomaterials Division, Cell Systems Science Group
NIST Research Advisor:	Dr. Bryant Nelson
Title of Talk:	Characterization and Correction of Measurement Biases in Microfluidic Chip-Based Resistive Pulse Sensing for Small Extracellular Vesicle Analysis

Abstract:

This research project focuses on the physicochemical characterization and use of extracellular vesicles (EVs) as non-viral drug delivery carriers. Exosomes, a specific population of small EVs ranging in size from 50 nm to 150 nm, are released when multilamellar vesicles fuse with cell membranes. Microfluidic resistive pulse sensing (mRPS) shows potential promise as a technique for the rapid, unbiased and high-resolution size and concentration characterization of small EVs, especially EVs in a polydisperse sample. Previously, mRPS has been used to determine particle number concentrations (PNCs) of EVs smaller than 150 nm. The technique requires only a small sample volume (a few microliters) and counts individual particles passing through a narrow channel constriction. A particle passing through the orifice alters the electrical resistance between two electrodes. This reproducible change in resistance, or "resistive pulse", is related to the particle's volume, and can be used to determine the diameter of individual particles. The number of pulses within a given time period is a measure of the PNC. While mRPS shows potential as a method for measuring EV PNCs, preliminary data (using cell-derived EVs) shows a need for a more thorough evaluation of any PNC measurement bias that might exist. To investigate this issue, fluorescently labeled polystyrene (PS) bead standards over several log dilutions are tested for PNCs via mRPS measurements under controlled conditions. The initial sample PS bead concentrations are verified via flow cytometry. The NIST COMET cell counting tool will be used to evaluate the mRPS PS bead data for sources of PNC measurement biases. Finally, a mRPS measurement protocol utilizing the most linear PS bead range will be utilized to test and measure the PNCs of several potential EV reference materials. The overall goal is to develop a mRPS standard protocol for unbiased EV PNC measurements.



SURF Student Colloquium

NIST – Gaithersburg, MD

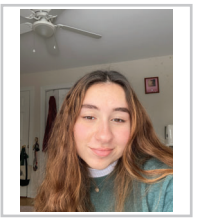
August 13-15, 2024

Name: Nuelle Johnson	
Academic Institution: University of Maryland, College Park	**Major:** Environmental Science & Technology
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	To attend graduate school for environmental metrology
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, 642.6
NIST Research Advisor:	Julie Rieland
Title of Talk:	Using Time-gated (TG) Raman to Characterize Marine Plastic Pollution from Hawaii

Abstract:

Plastic pollution has become a concerning issue in terms of ecosystem health, especially for marine ecosystems, where over 10 million tons of plastic enter the ocean each year. To address this issue, it is important to develop precise techniques for characterizing plastics so we can identify the most common types that are contributing to marine plastic pollution. One technique of interest is Raman spectroscopy, which is a non-invasive technique that uses laser light to measure the vibrational energy of scattered photons. Raman spectroscopy is a favorable technique being that it requires relatively little sample preparation and is sensitive to structural features that are not easily seen with infrared spectroscopy, such as aromaticity. The drawback to using Raman, however, is that there is often interference from fluorescence, which can overwhelm the Raman signal making it difficult to distinguish between different plastics.

Time-gated (TG) Raman is a recent technique that was developed to isolate the Raman and fluorescence signals by exploiting the time-delay of the fluorescence signal. In this interlaboratory study, TG Raman was used to analyze 58 plastic samples collected from a shore in Hawaii in order to compare the technique with other methods of analysis, such as attenuated total reflectance Fourier transform infrared spectroscopy (ATR FT-IR) and Differential scanning calorimetry (DSC). The ocean samples examined varied in color, size, shape, and type of plastic material. Each ocean sample was examined via TG Raman as received, and then after various levels of cleaning including surface scraping, acetone, and other solvents. Some samples were easier to identify than others. Solid plastic samples with a clear or white color yielded the clearest results after cleaning. Colors such as yellow and brown often yielded intermediate results, with interference from noise but still some distinguishable peaks. Red and black samples were the most challenging--yielding high levels of fluorescence and noise likely due to the coloring agent.



SURF Student Colloquium

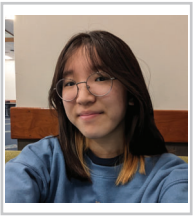
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Selana Kurutan
Academic Institution:	Saint Anselm College
Major:	Chemistry
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	I plan to attend graduate school to pursue my PhD in Chemistry.
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Material Measurement Science Division, Nanomaterials Research Group
NIST Research Advisor:	Dr. John Pettibone, Dr. Tae Joon Cho
Title of Talk:	Evaluating separation efficiency of secondary micro and nanoplastic controls to improve particle identification and characterization.

Abstract:

With the increasing concern regarding micro and nanoplastic particles (MNP) as a risk to human and environmental health, research to develop methods for detecting and characterizing MNP is necessary. The foundational properties of secondary MNP, which are broadly defined as deteriorated products from larger plastic sources, such as shape, size, and surface composition, could pose unique hazards from their bulk and micro-size counterparts. Size, morphology, and surface composition have been previously identified for engineered nanomaterials as primary properties associated with increased toxicity, but understanding of specific risks associated with MNP have only begun. Property accessibility also requires developing new sample preparation methods, because single measurement methods are insufficient for full particle characterization. Here, we used cryomilling to produce secondary MNPs test materials with largest dimensions below 20 μm. The cryomilled (CM) plastics were used to evaluate whether current methods adequately probe the properties of interest. We first developed a procedure to evaluate the reproducibility MNP production through combination of filtration and light scattering measurements. We used UV-Vis to calibrate the mass of MNP that were captured on filter to examine the contributions from particle dispersion, through sonication and surfactant type, and filter performance by evaluating effects from filter type, pore geometry, mass loading, and surface area. Biases in the filtration process were examined by comparing the particle size distributions (PSD) in the filtrate to the particle distributions captured on the filter, using laser diffraction (LD), optical microscopy, and hyphenated asymmetric flow field fractionation (AF4) with multi-angle light scattering (MALS). The well-dispersed suspensions provided an opportunity to assess the entire particle size distribution by combining data sets. LD has a working size limit above 10 m, while AF4-MALS requires all particles within a suspension to be approximately below the LD limit. Additionally, image processing methods of micrographs are more efficient in the absence of agglomeration and drying artifacts, which were minimized through sonication methods, surfactant type, and MNP concentration. We found that nylon mesh filters allow more MNP mass through than the uniform pore structure of polycarbonate filters. Additionally, we have found that previously reported dispersion concentrations overloaded filters, introducing possible biases into reported PSD. Combining the newly developed UV-Vis calibration method, filter efficiency evaluations, and PSD measurements, the CM test materials properties, such as size, morphology, and particle-surfactant interactions, can be used to developed improved methods for benchmarking MNP characterization and degradation in more applied systems.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Joanna Li
Academic Institution:	University of Illinois at Urbana-Champaign
Major:	Computer Engineering
Academic Standing (Sept. 2024):	Sophomore
Future Plans (School/Career):	Obtain a Master's degree, potentially after working for a few years in industry/R&D
NIST Laboratory, Division, and Group:	MML, Materials Measurement Science Division, Nanomechanical Properties Group
NIST Research Advisor:	Dr. Feng Yi
Title of Talk:	Differential Nanocalorimetry Circuit Measurements

Abstract:

Nanocalorimetry allows for the rapid measurement of thermal properties at a very small scale. Being able to understand the thermal behaviors of nanoscale materials is essential to improving the performance and heat dissipation of microelectronic devices. This is key in reducing costs and increasing yield within the field of semiconductor fabrication. The goal is to employ differential measurement methods to further improve measurement sensitivity. The main technique that was utilized in these experiments is thin-film differential scanning nanocalorimetry, which uses silicon-based chip sensors and pulses of current through the sample to quickly increase temperature. Given that the calorimetric cell works in a nearly adiabatic experimental mode, the differential form of heat capacity can be calculated from the measured voltage and current.

The programs PSpice and LTSpice were used to simulate the effect of the rise in temperature (modeled by varying resistances) on the experimental circuit's output and gain. In particular, two separate instrumentation amplifier ICs, the TI INA101 and TI INA849 models, were compared under simulated effects to identify potential differences in operation and efficiency. Selecting the appropriate chip would optimize the circuit further and speed up the development process. The results from the simulations were then used in tandem with the testing of the physical circuit to identify improvements in circuit design that could increase the measurement sensitivity of the device.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Charles Mann
Academic Institution:	Lafayette College
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate school/research
NIST Laboratory, Division, and Group:	MML, Materials Science and Engineering Division, Mechanical Performance Group
NIST Research Advisor:	Dr. Mark Stoudt
Title of Talk:	Understanding the Role of Nitrogen Content on Performance of 17-4PH Stainless Steel.

Abstract:

17-4PH stainless steel is an important industrial alloy and is widely used for applications that require high-strength and good corrosion resistance. In wrought form, 17-4PH is a two-phase structure primarily consisting of delta-ferrite stringers in a precipitation-hardenable martensite matrix that can be heat treated to achieve a specific strength. However, when it is processed for additive manufacturing from nitrogen-atomized powder, the microstructure becomes a mixture of martensite and meta-stable retained austenite that persists after post-build heat treatment. This study evaluates how much nitrogen is required to produce a change in the corrosion resistance and in the austenite content. To measure the nitrogen influence in this alloy, 4 analog compositions were arc melted and then suction cast. Each analog ingot contained: (0.154Cr, 0.043Ni, 0.040Cu, 0.0027Nb, 0.0005C) by mass fraction. The nitrogen was introduced using a sufficient quantity of Fe2N to produce a corresponding mass fraction of nitrogen that systematically ranged between (0.00 % to 0.15 %). After melting, the ingots were homogenized for 2 h at 1150 °C followed by a water quench. The corrosion resistance was evaluated as a function of the nitrogen content using electrochemical polarization experiments in a chloride containing environment with a neutral pH. Scanning electron microscopy (SEM), Electron energy dispersion spectroscopy (EDS), electron backscattered diffraction (EBSD), and Vickers microhardness tests were used to determine the microstructure and the performance of the alloys.

SURF Student Colloquium

NIST – Waimanalo, HI

August 13-15, 2024

Name: Remi Mellinghoff

Academic Institution: Yale University | **Major:** Environmental Engineering

Academic Standing (Sept. 2024): sophomore

Future Plans (School/Career): graduate school

NIST Laboratory, Division, and Group: Material Measurements Laboratory, Chemical Sciences Division, Group 11 Biochemical and Exposure Sciences Group

NIST Research Advisor: Jennifer Lynch

Title of Talk: The Rate of Chemical Changes during Outdoor Sunlight Weathering of Polyamide Pellets

Abstract:

Ghost fishing is a worldwide problem that occurs when derelict fishing gear continues to trap and kill marine animals. Fishing nets and lines are often made of nylon and are one the main sources of marine debris on the Hawaiian Islands. In order to develop methods to address ghost fishing and inform recycling efforts, it is important to understand how environmental weathering causes chemical and structural changes in nylon. In this study, the photo oxidation of 4 varieties of nylon (PA6, PA6-6, PA11, and PA12) was tested. Virgin pre-production pellets of nylon were placed on calcium-carbonate-based sand in terracotta pots in March of 2024 and subjected to ambient outdoor sunlight. Identical pellets in pots were placed under a plywood box for a dark treatment. They were set outside of the Hawaii Pacific University Center for Marine Debris Research in Waimanalo on Oahu, Hawaii and temperature (both treatments) and Ultraviolet A (light treatment only) were monitored continuously. One pellet per nylon variety was collected at the following time points: Days 1, 2, 3, 4, 7, 11, 18, 36, 50, 90, 120, and will continue every 3 months until the one-year mark. Each pellet was sliced into cross section, exterior, and interior fragments to measure penetration of chemical changes. Light microscopy was used to visually evaluate structural changes while attenuated total reflection- Fourier transform infrared spectroscopy (ATR FTIR) and differential scanning calorimetry (DSC) were used to test for chemical changes. The carbonyl index and changes in melting temperature or crystallinity will be plotted against photooxidation time to create calibration curves that may allow for environmental aging of derelict fishing gear or other marine debris. This study provides the basis for understanding how nylons degrade by photooxidation, and allows us to make more informed decisions regarding the fate of marine debris in the environment.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Sasha Menchaca

Academic Institution: Northwestern University | **Major:** Biomedical Engineering

Academic Standing (Sept. 2024): Senior

Future Plans (School/Career): Get my master's degree in biomedical engineering from Northwestern University

NIST Laboratory, Division, and Group: MML, Thermodynamics and Kinetics Group

NIST Research Advisor: Samantha Webster

Title of Talk: "High-Speed In-Situ X-ray Imaging of Powder Particle Behavior in Laser Powder-Blown Directed Energy Deposition"

Abstract: Laser powder-blown directed energy deposition (DED-LB) is an additive manufacturing technique in which powder is delivered through a nozzle head to a molten pool on the surface of a substrate created by a laser. DED can be utilized for both precise substrate damage repair and intricate geometry deposition. In addition to challenges like pore formation and defect generation on the substrate, there is minimal research on how individual powder particles behave within the melt pool and cause these deformations. Current research focuses on areas outside of the melt pool. To observe individual powder particle impact behavior, a custom-built powder-blown DED setup was used for highspeed, in-situ phase-contrast X-ray imaging at beamline 32-ID at the Advanced Photon Source. Titanium-6Al-4V and SS316 powders with a particle size of 45 µm to 106 µm were observed to assess differences between two materials. Experiments were conducted over a variety of deposition conditions and powder particle velocity was changed over a range of 8.4 to 37.7 m/s using the shield gas flow through the powder nozzles. Qualitive analysis of the images focused on particle impacts, pore release, movement of pores within the melt, partial melting of powder particles, powder adhesion, vapor cavity formation and spatter formation. Quantitative measurements using ImageJ included impact velocity, entrance angle, clad surface angle, particle and pore diameter, and vapor cavity dimensions. This detailed observation of phenomena like vapor cavity and pore formation provides insights into defects generated during the DED process and potential methods for optimizing the process.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Austyn Nguyen
Academic Institution:	University of Michigan-Ann Arbor
Major:	Computer Science
Academic Standing (Sept. 2024):	Undergraduate Freshman
Future Plans (School/Career):	Master's in Computer Science and MBA
NIST Laboratory, Division, and Group:	MML, 642.05
NIST Research Advisor:	Daniel Wheeler
Title of Talk:	Developing a FAIR-compliant Metadata Standard for Phase Field Data using Semantic Web Resources

Abstract:

In computational materials science, there is a need to generate FAIR digital assets which include the entire simulation workflow alongside raw and post-processed data generated during the execution. According to FAIR principles, digital assets must include adequate metadata for a machine system to find and repurpose the data for subsequent research activities. Recently, RO-Crate has become a popular mechanism for packaging research data with its metadata using previously established machine-ready semantic web standards. This semantic web standard relies on Schema.org annotations embedded in JSON-LD. Our work discusses the adoption of the RO-Crate standard to describe phase field simulations which model micro-scale phenomena such as microstructure formation in materials. We use a number of software libraries developed by the RO-Crate community to demonstrate how a phase field simulation can be packaged along with other significant aspects of the metadata, including the computational environment, numerical schemes, and problem specification. However, current iterations of RO-Crate have a number of deficiencies when considering an ideal metadata standard for computational materials science. These shortcomings include a lack of a standard for describing tabular data and a lack of clear semantics for the problem specification. This work presents a concrete demonstration of archiving a phase field simulation with RO-Crate while also addressing the key RO-Crate deficiencies.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Maximilian Niebur
Academic Institution:	Johns Hopkins University
Major:	Materials Science & Engineering and
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Ph.D Program
NIST Laboratory, Division, and Group:	Material Measurement Lab; Materials Measurement Science Division; Data & AI-Driven Materials Science Group
NIST Research Advisor:	Howie Joress, (Austin McDannald, Tae Joon Cho)
Title of Talk:	Mapping Synthesis Landscapes for Metal-Organic Frameworks for Carbon Capture

Abstract:

Carbon capture has emerged as an essential part of global efforts to limit global warming to 2 °C, to help mitigate carbon from sources that cannot necessarily be eliminated. Metal-organic frameworks (MOFs), have shown promise as possibly reusable carbon capture technology thanks to their incredibly high surface area and highly tunable sorption properties. MOFs are composed of metallic ions joined by organic linkers, the combination of which can be chosen to maximize competitive sorption of one gas, such as CO2. MOFs also have the ability to desorb the CO2, where it can be collected, and the MOF reused. One MOF that has shown promise in CO2 adsorption is CuBTC, or HKUST-1, which is composed of copper ions bridged by 1,3,5-benzenetricarboxylate. However, studies on its adsorption properties have primarily focused on demonstrating its possible applications and are lacking examination of the broader landscape of parameters and pathways. Existing literature addresses neither the limits of the synthesis space, nor the optimal parameters. Authors typically only report a single formula which works for their purposes, and omit any errant results, even though those results can add useful information for future work, particularly for developing computational materials models. Here, we explore in depth the effects of synthesis parameters on the MOF produced. To most effectively explore the space of synthesis parameters, we constructed a recipe recommendation engine, which uses a Gaussian process to study the synthesis landscape. Samples were characterized using x-ray diffraction and FTIR spectroscopy to measure the crystallinity, crystal size and purity of the product. Tests will be run to characterize the adsorption properties by performing Fourier transform infrared spectroscopy under flow of single gasses and mixed air to characterize the pure and competitive adsorption properties. This approach will elucidate optimal synthesis parameters for MOF-based CO2 sorbents.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sophia Rankin
Academic Institution:	Loyola University of Chicago
Major:	Forensic Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	I plan to pursue a Ph.D. in Toxicology/Pharmacology.
NIST Laboratory, Division, and Group:	Material Measurement Laboratory-NIST Center for Neutron Research, 646.05
NIST Research Advisor:	Dr. Jamie Weaver
Title of Talk:	Quantification of Bubble Defects Within Candidate Standard Reference Material Glasses

Abstract:

Glass is a critical source of forensic information as it is the most common evidence collected from crime scenes. Typical forensic examinations of automotive "float" glass fragments include Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) and micro-X-ray Fluorescence Spectroscopy (μ-XRF). Both techniques, calibrated with standards, are used in forensic casework to quantify elements and improve glass databases. Current glass Standard Reference Materials (SRMs) are certified for use in bulk sample analysis, however, may be unsuitable for the microanalysis of glass forensic evidence. Therefore, development of new SRMs representative of modern float glass is of critical importance to the field of forensic glass examination. Three candidate reference float glasses were developed for use as a ranged set of matrix-matched calibration standards. Initial steps toward qualification of new SRMs include use of optical microscopy and machine learning-guided image processing to quantify material defects that have the potential to impact LA-ICP-MS and μ-XRF results. Quantification of bubble defects (e.g. range of sizes and number of defects) within the candidate SRM glasses will be discussed. Additionally, a comparison of bubble characteristics will be made between candidate reference materials.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Maya Reid
Academic Institution:	Yeshiva University
Major:	Biology
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Pursue a career in the healthcare field
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Biomolecular Measurement Division, Biomolecular Structure and Function Group
NIST Research Advisor:	Nicholas Callahan
Title of Talk:	Surface Variants of the NISTmAb

Abstract:

An increasing number of protein biologic pharmaceuticals are antibodies due to their specificity and effectiveness. Despite the availability of advanced technologies for protein characterization, a universally accepted approach for predicting protein qualities has not yet been implemented. There is a recognized need to establish a standardized approach for predicting how mutations in monoclonal antibodies (mAb) may impact the stability of the molecule. Such an approach will allow for a decreased response time and an increase in the supply chain quality of vaccines and other therapeutics giving patients quicker access to life-saving products. An antibody is a “Y” shaped molecule composed of four proteins— two heavy chains on the bottom composing the Fc fragment that interacts with cell surface receptors, and two light chains that compose the Fab region which binds to the antigen. Using the NISTmAb the project seeks to establish a standard framework to evaluate antibody stability and expedite the understanding of ‘smart’ experimental approaches proposed to measure the stability. Surface mutations were made on the NISTmAb by strategically swapping a positive charge on the Fc chain to glutamate. Plasmids carrying the mutant gene were initially amplified in Escherichia coli, followed by purification and determination of the DNA concentration. Afterwards, the DNA was transfected into Chinese hamster ovary cells for expression and further purified using a protein L column. The protein then underwent multiple tests to reveal if the mutations appreciably altered important characteristics of the antibody. Measurements by Differential Scanning Fluorimetry assessed the structural integrity of the protein based on fluorescence readings as heat was applied and the protein unfolded. Additionally, Biolayer Interferometry readings provided the on and off binding rates of the antibody to protein L which binds to the light chain and protein A which binds to the heavy chain. The results of these tests, among others, can be compared to the known values of the NISTmAb to establish new model molecules of different antibody behaviors.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

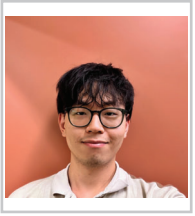
Name:	Annabel Shim
Academic Institution:	The Ohio State Ubiversity
Major:	Material Science and Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Unsure
NIST Laboratory, Division, and Group:	MML group 5
NIST Research Advisor:	Samantha Webster
Title of Talk:	The Effect of Laser Beam Shape on Material Structure in Directed Energy Deposition

Abstract:

Laser Power Blown Directed Energy Deposition (DED-LB) is an additive manufacturing technique where powdered metal is deposited onto a substrate and melted using a laser under shielding gas, typically argon. This process involves rapid heating and cooling cycles that can induce various defects including residual stress, porosity, cracking, delamination, and high surface roughness. Recent research has shown that the formation of these defects and final material quality can be heavily influenced by laser parameters and beam shape.

During deposition of material, the shape of the laser beam directly influences the temperature distribution across the melt pool. Altering beam shape affects how heat is distributed within the melt pool and consequently changes both the flow and cooling rate of the melt pool. Ultimately, differences in such lead to changes in grain structure and affect formation of defects. Conventional Gaussian beams often lead to instability in the melt pool, resulting in porosity and coarse grain structure. In contrast, alternative beam shapes such as top hat or multimode beams with Gaussian and ring mode distributions offer potential for improving material properties and microstructure, but have been minimally studied in DED-LB.

To study the effect of laser beam shape on material structure, a custom-built DED-LB system called the System for AM Alloy Development (SAMAD) was designed. The SAMAD's deposition head consists of a coaxial ring nozzle to dispense powders and optics for two different lasers – either multimodal or top hat. This system was used to create 15 mm single line tracks with each laser (a total of eight different beam shapes). Subsequent analysis with EBSD maps and optical imaging evaluated each track's performance, noted by microstructure, defect occurrence, and clad dimensions. This exploration of different beam shapes is critical for understanding the link between processing parameters and material structure in metal additive manufacturing.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Halen Solomon
Academic Institution:	Goerge Washington University
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Recent Graduate
Future Plans (School/Career):	Start working as a PREP research associate this fall; eventually pursue a Ph.D. in material science.
NIST Laboratory, Division, and Group:	MML, Material Science and Engineering Division, Polymers and Complex Fluids Group
NIST Research Advisor:	Paul Salipante
Title of Talk:	Small-volume Characterization of Solutions using On-demand, Droplet-generating Microfluidics

Abstract:

Today, an increasing number of pharmaceutical drugs include larger and more complex compounds like monoclonal antibodies and other modified protein complexes while simultaneously being low-volume products with high concentrations of the active protein compound. To create such solutions, newer and larger amounts of excipients are added to help stabilize the formulation by preventing changes in rheological behavior and protein aggregation. Accurately measuring and determining the optimal concentration of each component, though constrained by the resource-intensive nature of procurement, becomes even more critical.

Our project aims to characterize these properties by utilizing microfluidic devices to aid in the dispensing of solutions at a sub-microliter scale. Unlike traditional approaches, which can only create continuous streams of droplets, our device can generate a singular droplet on demand by utilizing a combined pneumatic-syringe pump approach. The device is manufactured from PTFE-coated polyimide films and borosilicate glass to create channels that can withstand high pressures without deformation. Syringe pump controls are used to create, combine, and mix droplets in an immiscible carrier fluid. Pneumatic controls are then used to transfer the droplets to a separate channel for optical characterization methods such as light microscopy and light-scattering techniques.

Our aim is to use the device to study concentration-dependent solution behavior and protein-protein interactions within solutions by creating droplets with different combination of solutes. We test the dilution capabilities by using a solution of fluorescent particles. We also map phase diagrams of solutions containing polymer-protein complexes. We hope to further the approach by including more component streams and implementing automation of certain functions of the device.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Eliana Szabo
Academic Institution:	Carnegie Mellon University
Major:	Material Science and Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	Materials Measurement Labratory, Division 642, Group 6
NIST Research Advisor:	Paul Roberts
Title of Talk:	Effects of Thermal History on Semicrystalline Morphology of Polypropylene During Fused Filament Fabrication

Abstract:

Semicrystalline polymers are often used for industrial manufacturing as they are easy to handle and require little energy to transition phases. Polyolefins in particular, such as polypropylene, are chemically resistant and inexpensive making them ideal for manufacturing. However, products made from semicrystalline polymers can experience significant warpage and residual stresses due to the large volume change during crystallization. Fused Filament Fabrication (FFF) is a type of 3D printing manufacturing technique involving layer-by-layer deposition of a polymer, enabling inexpensive production of highly customizable designs. Combining the advantages of polyolefins with the customizability of FFF could result in higher quality products. However, the complex thermal history caused by partial remelting of the previous layer as each new layer is printed results in uneven crystallization and heterogeneous morphologies that directly impact the print's mechanical properties.

In this project, we investigate the relationship between thermal history and semicrystalline morphology of polypropylene during FFF. We use IR thermography during printing to relate changes in temperature to the crystallization state of the polymer. We then recreate the measured thermal profiles on a temperature-controlled microscopy stage while simultaneously performing polarized optical microscopy (POM), to obtain an in-situ view of the partial melting-recrystallization behavior that occurs during FFF. Further, we use POM to image cross sections of components printed with FFF. From the cross-sections, we observe a morphological transition within the bulk of each printed layer, which we attribute to recrystallization. To determine the cause of recrystallization we vary extrusion temperature, filament feed rate, printing velocity, layer height and nozzle diameter. The extent of propagation of the morphological transition varies systematically with inter filament contact area, where an increase in the contact area causes more propagation. To quantify thermal dependency, we measure the distance between the weld line and its corresponding recrystallization front. Finally, we conduct mechanical testing to study the correlation between the position of the recrystallization front and the strength of the sample. Our results show the sensitivity of semicrystalline polymers to thermal history and the importance of process conditions for successful FFF using polyolefins, and semicrystalline polymers in general.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Theresa Thomas
Academic Institution:	College of William & Mary
Major:	Anthropology
Academic Standing (Sept. 2024):	Graduated Class of 2024
Future Plans (School/Career):	Career in Physical or Social Sciences, with plans to attend Graduate School
NIST Laboratory, Division, and Group:	Materials Measurement Laboratory, Laboratory Office, Selected Programs and Initiatives
NIST Research Advisor:	Noah L. Last
Title of Talk:	What's the Big Idea? Expanding Scientific Communications for MML Programs

Abstract:

The Materials Measurement Laboratory (MML) upholds NIST's mission of supporting U.S. industry through meticulous research. Scientific communications converts this technical research into clear resources for various audiences, including experts and the public. Communications by the Public Affairs Office (PAO) and the MML Communications Specialist highlight certain aspects of MML's work. While the PAO liaison communicates headline research to external audiences, the MML Communications Specialist addresses the internal audience. Scientific communications for MML programs exist at the nexus of the PAO and MML Communications Specialist roles because it shares goals and audiences with each. This SURF project investigates best practices for effective scientific communication to support external engagement with MML programs based on two case studies: the MML Additive Manufacturing program (MML AM) homepage and the user experience for the Circular Economy Resource Registry (CERR).

Improving scientific communication could support MML internally and externally by fostering internal and external stakeholder collaboration through increased engagement with MML programs web content and deliverables. The goals, audiences, and user experience considerations for both cases were identified and recorded to inform content development and methods for stakeholder engagement. Best practices—including tools, methods, and other considerations for effective communication—were recorded and will be presented to MML leadership. Finally, MML is adding to and expanding its programs. These best practices will aid development and maintenance of scientific communications in support of MML programs and other NIST Organizational Units (OUs).

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Vincent Tsai

Academic Institution: University of Maryland College Park

Major: Physics and Computer Science

Academic Standing
(Sept. 2024): Junior

Future Plans
(School/Career): Unsure

NIST Laboratory,
Division, and Group: MML, Materials Science and Engineering Division, Functional nanostructured materials (642.03)

NIST Research
Advisor: Dr. David Raciti

Title of Talk: Curved gratings for use in X-ray grating interferometry

Abstract:
X-ray absorption imaging is a standard tool used in the medical field, however, the technique is limited to samples with strong absorption of X-rays like bones. One method of imaging soft tissue is by using X-ray grating interferometry. A gold filled grating is used to create an array of coherent X-rays. The gold filled gratings are produced using superconformal filling via gold electrodeposition. These gratings are then placed at variable distances from the source to allow for differential phase measurement. In order to manufacture compact devices, the source and gratings must be placed closer together. However, the source of X-rays is divergent and hence the gratings must be curved to maintain performance over a large field of view. To create wafers with smaller radii of curvature, we developed a number of different mounts at different curvatures, we then analyzed the wafers for conformity and consistency by mapping the wafers with optical profilometry. Results demonstrate good retention of curvature even after removal from the mount. Additionally, the empirical improvements to the field of view agrees with mathematical models. Ultimately, this work supports the practical development and implementation of curved gratings for the improvement of X-ray grating interferometry.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Austin Vest
Academic Institution:	The University of Tennessee at Martin
Major:	Chemistry
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	I plan on continuing my education to earn my Ph.D. then finding work as a forensic chemist.
NIST Laboratory, Division, and Group:	Material Measurement Laboratory, Division 643, Group 5
NIST Research Advisor:	Dr. Elizabeth Robinson
Title of Talk:	Quantifying the Environmental Degradation of Trace Drug Residues Using Mass Spectrometry

Abstract:

When trace drug residues are recovered from a real-world situation, they have most likely been subjected to potentially unknown and variable environmental conditions. Knowing the behavior of drug residues when exposed to different environmental conditions is crucial information to aid law enforcement, first responders, and forensic practitioners. For example, it can help crime scene investigators decide if collection of a residue is possible under the conditions the scene has been exposed to. It can also help them decide how long and in what conditions a sample should be stored. This behavior could also help the instrument industry in refining their drug screening tools to take degradation products into account.

The goal of this project is to expose different types of trace (tens of nanograms) deposits of drug residues (ketamine, methamphetamine, and cocaine) to environmental conditions (-10 °C, 20 °C, 30 °C, 47 °C, 30 °C at 90% humidity, and UV exposure) over a total period of 42 days. Quantitative measurements are taken at various intervals over this period using electrospray ionization tandem mass spectrometry (ESI-MS/MS) to create a plot of the mass loss over time. Full mass spectral qualitative data was also collected by ESI-MS in positive mode to identify and better understand spectral abnormalities that could be attributed to degradation products formed due to unique environmental exposures.

Based on preliminary data, the harshest conditions are 47 °C and UV exposure, with the -10 °C and 20 °C conditions showing the least mass loss. The ketamine samples are currently showing the least mass loss while the methamphetamine and cocaine are seemingly losing more mass than ketamine and have around the same mass loss as each other. By the end, this data may aid law enforcement, first responders, and forensic scientists in understanding how drug residues behave in the real world.

SURF Student Colloquium

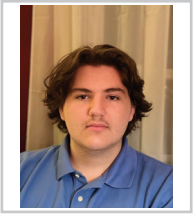
NIST – Gaithersburg, MD

August 13-15, 2024

Name: Ben Wenig	
Academic Institution: American University	**Major:** Chemsitry
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	PhD, Analytical Chemistry
NIST Laboratory, Division, and Group:	MML, Materials Science and Engineering Divison, Functional Polymers Group
NIST Research Advisor:	Dr. Jeremiah Woodcock
Title of Talk:	**Characterization Methods for Isotopic Trace Labeling of Cellulose Nanomaterials**

Abstract:

Cellulose nanomaterials (CNM) are starting to appear in many application spaces such as disposable products, food packaging, and medical applications. CNM undergoes heavy mechanical and chemical processing prior to use. The standard toxicity study used by regulatory bodies is through radiolabeling and scintillation. The impact of surface energy upon the fidelity of these studies is not well understood. A heterogeneous gas phase reaction was developed for surface trace labeling of cellulose nanofibers with minimized isotopic waste. Various solvent systems were studied to optimize surface labeling efficiency and post-reaction solvent removal. Digestion procedures are carried out to further characterize the extent of labeling with liquid chromatography tandem mass spectrometry. Surface energy analysis is performed via inverse gas chromatography, and Raman spectroscopy is employed to monitor reaction progression and optimize reaction conditions. This novel labeling technique allows for efficient tracking of modified cellulose in biological studies and for metrological development to further study the viability of cellulose as a rheological modifier.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Peter Winstel
Academic Institution:	Carnegie Mellon University
Major:	Physics
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School in Physics
NIST Laboratory, Division, and Group:	MML, Materials Science and Engineering Division, Thermodynamics and Kinetics Group
NIST Research Advisor:	Dr. Lucas Hale
Title of Talk:	High Throughput Calculations for Determining Liquid Properties

Abstract:

The NIST Interatomic Potentials Repository project is cataloging predictions for various materials properties across all hosted potentials to assist users in identifying which potentials are best suited for different use cases. Up to now, the property predictions have largely centered on crystalline materials, but is being expanded into exploring liquid phases. This research focuses on the creation of calculation methods that use the Large-scale Atomic/Molecular Massively Parallel Simulator (LAMMPS) molecular dynamics code to measure the diffusion coefficient and the kinetic viscosity of a liquid. These methods are integrated into IprPy, a python package that allows for the calculations to be ran as part of a high throughput workflow. Four new calculation methods were created, two for measuring viscosities and two for diffusion coefficients. The diffusion coefficients were calculated from the time derivative of the mean squared displacement, and the integral of the velocity autocorrelation function. The kinetic viscosities were calculated by measuring the velocity field of a sheared system, and by integrating the pressure autocorrelation function according to the Green-Kubo formula. Calculations were performed in high throughput across metallic interatomic potentials and a wide range of temperatures. The results of these calculations are used to compare predictions between the different calculation methods and potentials, and to explore relationships between different liquid properties.

NIST Center for Neutron Research 2024

Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

NIST Center for Neutron Research (NCNR)

Veronica Ivanovskaya - **NCNR plenary speaker**	Development of Lipid-Based Scaffolds with Extracellular Matrix Proteins for Tissue Repair
Sean Johnson	Characterizing the Stability of Surfactant-preservative Mixtures for Pharmaceutical Use
Thomas Murray (CORE)	Globular Protein Assembly in Bulk Solution and at the Air/Water Interface: Effect of Silicone Oil
Xael Shan (CORE)	Analyzing the Structure of Bicelles with Small Angle Neutron Scattering and Sasview
Marshall Butler	Impact of Process Parameters on Soft Nanoparticle Formulations for Capillary Rheology Studies
Adam Friedland	Magnetoelectric coupling in bulk single crystals of PMN-PT
Talya Lebson	Using Chemical Vapor Depostion to Grow Thin Film Actinide Compounds
Archana Parameswaran	Resolving the Spin Structure of Magnetic Topological Crystal NdSb Using Inelastic Neutron Scattering
Patrick Chen	Characterizing Weyl-mediated Magnetic Interactions in Non-centrosymmetric Rare-earth Materials
Elizabeth Baggett	Using AI to Classify Crystal Structure from Powder Diffraction Using Over 1,000,000 Patterns
Sophia Rankin	Quantification of Bubble Defects Within Candidate Standard Reference Material Glasses
Zoe Masters	Development of an Intelligent Monitoring System for the Cold Neutron Source Cryogenics System
Alex Caldanaro	Configuration Management of the National Bureau of Standards Reactor
Iman Syed	Verification of Thermal-Hydraulics Models for Nuclear Reactors with Plate-Type Fuels
Eric Swanson	NIST Neutron Source Initial Startup Core Loading Analysis

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Elizabeth Baggett
Academic Institution:	Boston College
Major:	Physics
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate school
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610
NIST Research Advisor:	William Ratcliff
Title of Talk:	Using AI to Classify Crystal Structure from Powder Diffraction Using Over 1,000,000 Patterns

Abstract:

Neutrons and x-rays are excellent probes of the structures of materials. Modern instruments are generating increasing data volumes, which require automation. In this project, we explore the ability to use neural networks to classify the space group and Bravais lattices of materials based on their powder diffraction patterns.

This project extends upon a previous students work using only the Inorganic Crystal Structure Database (210,000 structures). This student concluded that lack of data and bias within data led to the model's mistakes. So, we are adding massive amounts of data from the Cambridge Structural Database (1,200,000 structures) and the Crystallography Open Database (80,000 structures).

Additionally, I will discuss our attempts to classify multiphase powder diffraction patterns to locate and identify impurity phases.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Marshall Butler
Academic Institution:	BYU (BS) & Purdue University (MS)
Major:	Manufacturing Eng. emphasis in BioMed
Academic Standing (Sept. 2024):	First year master's student
Future Plans (School/Career):	After my master's degree I will eventually pursue a PhD, likely in Biomedical Engineering
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research (NCNR), Div. 610, Neutron-Condensed Matter Science Group
NIST Research Advisor:	Kelsi Rehmann
Title of Talk:	Impact of Process Parameters on Soft Nanoparticle Formulations for Capillary Rheology Studies

Abstract:

Therapeutic nanoparticles for drug delivery are an emerging branch of nanomedicine, including micelles loaded with a core material of drug or excipients and a stabilizing outer layer of poly(ethylene glycol) (PEG). Nanoparticle size, form, and stabilizing polymers assist in delivery, making the characterization of PEG relevant for pharmaceutical research. Capillary rheoSANS is a technique that can measure nanoparticle structure and capture shear-induced structural changes by passing samples through capillary tubing while measuring neutron scattering. Because the micelle structure is dependent on the method used to prepare them, new methodologies may affect the structure and rheology of these nanoparticles, especially when concentrated. In particular, we are interested in the more recently developed Flash Nanoprecipitation process for creating self-assembled, PEG-stabilized nanoparticles, a process which can be scaled up to make industrial production quantities while maintaining good process control. This project primarily focuses on first optimizing processing parameters for creating nanoparticles using the Flash Nanoprecipitation (FNP) process and then configuring the particles into more concentrated solutions. The first iteration of nanoparticles formed during these experiments is block-copolymer micelles without a therapeutic material in the core, synthesized using a multi-inlet vortex mixer. We will study the effect on particle size as a function of process parameters such as flow rates, concentration of polymer in the solvent stream, and ratio of solvent to water streams. Using dynamic light scattering measurements, we will measure the nanoparticle size and polydispersity for the samples when they are initially made by FNP and after undergoing different concentration procedures. Previous studies of concentrated nanoparticles have indicated a change in particle size and rheology as a function of time and temperature. We plan to measure the particle size over time and after exposure to different temperatures to better understand these effects and compare them to particles made by other methodologies.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Alex Caldanaro
Academic Institution:	The University of Vermont
Major:	Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	I currently plan on attending graduate school to study nuclear engineering
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610, Reactor Operations and Engineering
NIST Research Advisor:	Abdullah Weiss
Title of Talk:	Configuration Management of the National Bureau of Standards Reactor

Abstract:

The National Bureau of Standards Reactor (NBSR) is an aging research reactor built in the 1960s. This 20 Megawatt tank-type reactor utilizes heavy water (deuterium) as a primary coolant, moderator, and reflector. Over the 50 years since the NBSR initially became operational, advancements in technology and computing have revolutionized engineering design. One significant development is the use of three-dimensional Computer-Aided Design (CAD) models, which are now crucial in creating robust engineering designs. These programs also allow engineers to conduct simulations for stress, strain, and fluid flow analysis. Although much of the NBSR has been modeled in SolidWorks and other CAD programs, several structures, systems, and components remain to be digitized. Notably, this includes the subpile room, which is located immediately below the reactor and houses essential piping. The primary coolant inlet and outlets for the reactor, the fuel rod transfer system, and the overflow and level control valves are located in the subpile room and are vital for regulating the coolant flow through the reactor. To model these systems, a thorough review of available engineering drawings and floor plans was undertaken. Using these drawings, the subpile room and its systems can be digitized in SolidWorks, allowing for accurate geometric representations that support and enhance current configuration management efforts. Additionally, Finite Element Analysis (FEA) can be performed on specific systems using SolidWorks and COMSOL Multiphysics. The data derived from stress, strain, and fluid flow analysis will enable improvements in these systems, aiding in the efforts to restart the NBSR and enhance the design of the NIST Neutron Source.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Patrick Chen
Academic Institution:	University of Maryland, College Park
Major:	Physics and Math
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610
NIST Research Advisor:	Jonathan Gaudet
Title of Talk:	Characterizing Weyl-mediated Magnetic Interactions in Non-centrosymmetric Rare-earth Materials

Abstract:

Subatomic particles have an inherent property called spin, contributing a total spin to atomic particles. This allows them to be thought of as tiny magnets. Macroscopic properties such as magnetism can be determined by the alignments of the spins. Regions of aligned spins are called domains which result in a net magnetization of the area. Within a single crystal, there can be many domains with differing alignments and the transition from one domain to another is referred to as a domain wall. The behavior of spins is governed by interactions both local and across the crystal. The behavior in the domain wall is of interest as it reveals the effects of weaker interactions, in particular the Dzyaloshinskii-Moriya(DM) interaction which we hope to study in a class of materials known as Weyl semimetals, in particular CeAlSi and CeAlGe. In these materials, the DM interaction is mediated by Weyl electrons, which are massless and chiral particles. This results in a bond-dependent DM interaction between neighboring spins. To study this interaction, we have performed neutron scattering experiments as well as micromagnetic simulations of the domains and domain walls. Fitting these simulations to the neutron scattering data will give a better understanding of the length scales for these interactions and domain wall behaviors.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Adam Friedland
Academic Institution:	Reed College
Major:	Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursuing a PhD in physics
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610, Condensed Matter Science Group
NIST Research Advisor:	Shane Lindemann
Title of Talk:	Magnetoelectric coupling in bulk single crystals of PMN-PT

Abstract:

Magnetoresistive random access memory (MRAM) is an electronic data storage method using alternating magnetic/nonmagnetic layers in a stack to take advantage of giant magnetoresistance (GMR). Anti-parallel magnetic moments in consecutive layers increases the resistance of the stack compared to parallel moments, forming a basis for binary data storage. In traditional MRAM, orientation of the magnetic moments is changed using electrical current to create a magnetic field, which requires a large amount of energy. This project studies an alternative method utilizing strain-mediated magnetoelectric coupling to write bits. The device's substrate is a piezoelectric crystal, which generates strain under an electric field. This effect can be used to rotate the magnetic moments of magnetostrictive layers in the GMR stack. This method reduces the energy required to write bits by several orders of magnitude when compared to current-driven commercial and proposed RAM systems.

Here we replicate magnetoelectric coupling as demonstrated in previous research using cobalt and nickel thin films grown on (1-x)Pb(Mg1/3Nb2/3)O3-(x)PbTiO3 (PMN-PT) piezoelectric crystals. Achieving this effect requires experimental study of the ferroelectric and piezoelectric behavior of PMN-PT to reliably predict the material's response to an electric field. We investigate several methods of applying voltage, such as constant-voltage and constant-current methods, to stimulate changes in material strain. This will also provide insight into behavior of relaxor ferroelectrics (such as PMN-PT), which will assist in the development and optimization of next-generation MRAM devices.

SURF Student Colloquium

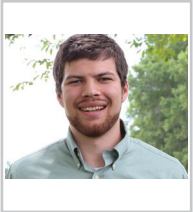
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Veronica Ivanovskaya
Academic Institution:	Johns Hopkins University
Major:	Materials Science and Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Continuing school for PhD or Masters
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610
NIST Research Advisor:	Minh Phan
Title of Talk:	Development of Lipid-Based Scaffolds with Extracellular Matrix Proteins for Tissue Repair

Abstract:

In the field of regenerative medicine, currently employed artificial materials in tissue scaffolds fail to introduce an environment that supports cellular growth and communication, which is imperative for tissue reconstruction. These conditions are naturally facilitated and regulated, however, by the extracellular matrix (ECM) surrounding cells and the interactions of proteins that constitute it: elastin, collagen, fibronectin, and laminin. By adhering native ECM proteins onto a lipid carrier system, it is to be expected that the platform would allow for heightened control of cellular growth, differentiation and other behavior by mimicking the natural scaffold ECM. This study aims to establish the fundamental interactions and the mechanical properties of the lipid platform and native proteins, later to implement our understanding into manipulating cellular behavior for wound healing. Through the characterization of the two-dimensional structure of the lipid-platform with and without deposition of protein, as well as looking at the structural depth profile with x-ray reflectometry, the influence of protein on the scaffold structure and properties will be observed. This will create the basis for future work involving ECM proteins and ECM-mimetic material in regenerative medicine and further research.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sean Johnson
Academic Institution:	Patrick Henry College
Major:	Environmental Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Commission into the United States Air Force
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610
NIST Research Advisor:	Rachel Ford
Title of Talk:	Characterizing the stability of surfactant-preservative mixtures for pharmaceutical use

Abstract:

Surfactants and preservatives are relied on to formulate pharmaceutical products that will be used for extended periods time. However, when nonionic surfactants such as poloxamer 188, polysorbate 80, and polysorbate 20 are combined with preservatives at certain concentrations, they become visibly turbid, leading to large-scale phase separation. Using a combination of visual assessment and benchtop scattering techniques, we have sought to characterize this turbidity, exploring how instability responds to different parameters, including temperature and composition. Our results indicate that the identity of the surfactant plays a significant role in preservative-induced instability. That said, all three surfactants exhibit the same type of response to temperature: as temperature is increased, the tendency to form turbid aggregates consistently increases. In total, this research will help the pharmaceutical industry better design formulation platforms for a wide variety of drug products.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Talya Lebson
Academic Institution:	University of Maryland, College Park
Major:	Physics and Psychology
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Physics PhD/Experimental Physics Research
NIST Laboratory, Division, and Group:	NCNR, 610, Condensed Matter Physics
NIST Research Advisor:	Dr. Nicholas Butch
Title of Talk:	Using Chemical Vapor Depostion to Grow Thin Film Actinide Compounds

Abstract:

Chemical Vapor Deposition (CVD) is a method of growing thin film crystals on a substrate. This method uses a furnace to heat up the element to turn it into a gas, and that gas then chemically bonds with the substrate to form a thin film growth. This growth technique is often used for growing thin film semiconductors to be used in electronic devices.

This project plans to use CVD to grow thin film actinide compounds. Since some actinide compounds are superconducting at low temperatures, this growth can have many interesting applications for future technology. I took part in the initial stages of this research, including researching this technique and the best substrates to be used, setting up the furnace, which was designed specifically for this project,and calibrating the equipment.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Zoë Masters	
Academic Institution: Rochester Institute of Technology	**Major:** Mechanical Engineering
Academic Standing (Sept. 2024):	5th Year, Accelerated Dual Degree BS/ME
Future Plans (School/Career):	Undecided, possibly pursue a PhD
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Division 610
NIST Research Advisor:	Robert Newby
Title of Talk:	Development of an Intelligent Monitoring System for the Cold Neutron Source Cryogenics System

Abstract:

The cold source is an important component of the research reactor at NIST, with its primary job to moderate and slow the neutrons so they are in an appropriate energy state to be used for experiments. When normally operating and something goes wrong with the cold source system there is a limited timeframe, approximately 20 minutes, to correct the issue. If the issue is not corrected quickly the reactor enters a state where it can't be recovered for a minimum of 48 hours. The cold source system has many components and they're spread out through multiple buildings which creates another obstacle in solving problems quickly. For this reason, it is important that operators have an interface to troubleshoot cold source alarms.

My contribution to the NCNR is the development of a graphical user interface (GUI) that guides reactor operators through cold source alarms and will improve troubleshooting efficiency. Significant time has been devoted to learning how all the components of the cold source system work together. This understanding of the system allowed for the creation of decision trees for alarms. The alarms range from cryogenics, vacuum, compressors, coolant pumps, and turbines. These decision trees are being developed to expedite reactor operations response using a Python GUI front end to guide in problem identification and isolation.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Thomas Murray
Academic Institution:	Fayetteville State University
Major:	Chemistry with Material Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Law School upon graduation, then Intellectual Property Attorney.
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research, Div. 610, CORE Program
NIST Research Advisor:	Guangcui Yuan
Title of Talk:	Globular Protein Assembly in Bulk Solution and at the Air/Water Interface: Effect of Silicone Oil

Abstract:

Silicone oil is commonly used in pharmaceutical packaging for several important reasons: enhance lubrication, aid manufacturing efficiency, ensure better drainage, minimize product adhesion, and preserve containers transparency. There is a general concern that the silicone oil may leach into the drug product, potentially affecting its purity and efficacy. Leachable silicone oil can also lead to protein denaturation and protein aggregation. Understanding and managing leachable silicone oil are essential for ensuring drug safety and maintaining product quality. In this work, we investigate how a globular protein (bovine serum albumin) interacts with the silicone oil. Dynamic light scattering evaluates the aggregation of proteins in bulk solution. X-ray reflectometry measures the interfacial layer thickness and protein immersion into the oil phase at the interface. In summary, this research contributes to safer and more effective pharmaceutical packaging by considering protein behavior and its interaction with leachable substances.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Archana Parameswaran

Academic Institution: College of William & Mary | **Major:** Physics and Mathematics

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career): Graduate School

NIST Laboratory, Division, and Group: NIST Center for Neutron Research, Div. 610

NIST Research Advisor: Jonathan Gaudet

Title of Talk: Resolving the spin structure of magnetic topological crystal NdSb using inelastic neutron scattering

Abstract:

New research has revealed interesting properties of a class of materials known as topological insulators. Topological insulators have insulating bulk properties and topologically-protected conducting surface states where electrons act as massless chiral particles, or photons with a magnetic moment. The applications of topological insulators include furthering understanding of intrinsic quantum spin, quantum information, and spintronics. LaBi and LaSb, which are non-magnetic rare-earth monopnictides, have already been revealed to be topological insulators, and further research is being performed on substituting La with magnetic rare-earth ions to study the effect of magnetism on the properties of these surface states. In particular, unconventional surface states were discovered in NdSb and NdBi, states believed to be caused by their spin structure. Two competing spin structure theories of NdSb and NdBi are disputed in the literature: 1k and 2k. Neutron diffraction is normally the method of choice to determine the spin structure of a material, but in this case, it fails to distinguish between the 1k and 2k spin structures. Therefore, we used inelastic neutron scattering to probe NdSb, analyze its spin dynamic, and deduce its spin structure.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Sophia Rankin
Academic Institution:	Loyola University of Chicago
Major:	Forensic Science
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	I plan to pursue a Ph.D. in Toxicology/Pharmacology.
NIST Laboratory, Division, and Group:	Material Measurement Laboratory-NIST Center for Neutron Research, 646.05
NIST Research Advisor:	Dr. Jamie Weaver
Title of Talk:	Quantification of Bubble Defects Within Candidate Standard Reference Material Glasses

Abstract:

Glass is a critical source of forensic information as it is the most common evidence collected from crime scenes. Typical forensic examinations of automotive "float" glass fragments include Laser Ablation Inductively Coupled Mass Spectrometry (LA-ICP-MS) and micro-X-ray Fluorescence Spectroscopy (μ-XRF). Both techniques, calibrated with standards, are used in forensic casework to quantify elements and improve glass databases. Current glass Standard Reference Materials (SRMs) are certified for use in bulk sample analysis, however, they may be unsuitable for the microanalysis of glass forensic evidence. Therefore, development of new SRMs representative of modern float glass is of critical importance to the field of forensic glass examination. Three candidate reference float glasses were developed for use as a ranged set of matrix-matched calibration standards. Initial steps toward qualification of new SRMs include use of optical microscopy and machine learning-guided image processing to quantify material defects that have the potential to impact LA-ICP-MS and μ-XRF results. Quantification of bubble defects (e.g. range of sizes and number of defects) within the candidate SRM glasses will be discussed. Additionally, a comparison of bubble characteristics will be made between candidate reference materials.

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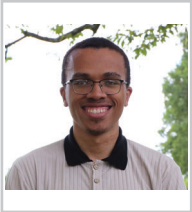
NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Ting/Xael Shan
Academic Institution:	University of Maryland: College Park
Major:	Computer Science
Academic Standing (Sept. 2024):	Freshman
Future Plans (School/Career):	B.S./M.S. in Computer Science and B.S. in Immersive Media Design
NIST Laboratory, Division, and Group:	NIST Center of Neutron Research, Div. 610
NIST Research Advisor:	Elizabeth Kelley, Paul Butler
Title of Talk:	Analyzing the Structure of Bicelles with Small Angle Neutron Scattering and Sasview

Abstract:

Membrane proteins are important to study to improve our fundamental biological understanding as well as develop new pharmaceutical targets, but are difficult to stabilize outside of the cell membrane environment. A bi-layer micelle, or bicelle, is a lipid model matrix often used in studies of membrane proteins; however, the membrane environment can also affect the protein structure and function during the experiments. Therefore, the model membrane properties also need to be known. The ideal bicelle is typically depicted as having a perfectly segregated rim - made of short tail lipids such as dihexanoylphosphatidylcholine (DHPC) - and a flat planar region - made of bilayer forming lipids such as dimyristoylphosphatidylcholine (DMPC). While there is a segregation of DHPC and DMPC, there is also a degree of mixing, especially in the rim. Here, we use Small Angle Neutron Scattering (SANS) to develop an accurate picture of the DHPC/DMPC bicelle structure. To do this, we analyze SANS data for both DHPC micelles and DHPC/DMPC bicelles to determine the true shape, distribution of DHPC and DMPC lipids, and hydration of the shell region at a given composition commonly used in experiments. Mixtures of protiated and deuterated solvents and lipids were used to highlight the different parts of the samples' structures and avoid sample and solvent matching. SANS data for samples of DHPC micelles in D2O/H2O mixed solvents were collected on the NG7 and D22 SANS instruments. Deuterated DHPC samples were also run through the same procedure and compared with the protiated samples. Bicelle samples containing mixtures of protiated lipids and deuterated lipids in varying ratios of D2O/H2O were also studied. Models for the micelle and bicelle structures were implemented in analysis software, Sasview, and used to determine the shape, length parameters, and shell SLD; this was then used to determine the hydration and aggregation number. The data showed that the bicelles are most mixed in the rim (DHPC); we compare the rim and DHPC micelle's properties in order to determine the degree of segregation.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Eric Swanson
Academic Institution:	Montclair State University
Major:	Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Advanced degree in Nuclear Engineering
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research (NCNR), Div. 610, Reactor Operations and Engineering
NIST Research Advisor:	Dr. Abdullah Weiss & Dr. Osman Celikten
Title of Talk:	NIST Neutron Source Initial Startup Core Loading Analysis

Abstract:

A preconceptual design for NIST Neutron Source (NNS) is under development to replace the existing NSBR reactor. The NNS contains a light water moderated and cooled core which provides neutrons for domestic or international scattering and irradiation experiments. The core is planned to be a 3x3 rectangular core fueled with U-10Mo curved plates with aluminum cladding. Each fuel assembly consists of 21 fuel plates, each of a known composition and position. In order to optimize the composition, quantity and position of the fuel plates in the burnt assemblies at the startup cycle, a MATLAB analytical code has been developed. This code identifies the enrichment across each assembly and plate by compiling a Monte Carlo N-Particle (MCNP) input file. Furthermore, in order to analyze the effects of the different fuel configurations on core behavior, a MCNP output compiler has been developed. By considering the fission products of the configured core, the enrichment equivalence can be determined. Ultimately, after the core configuration, the criticality safety assessment of the NNS core during the initial startup core loading can be determined.

SURF Student Colloquium

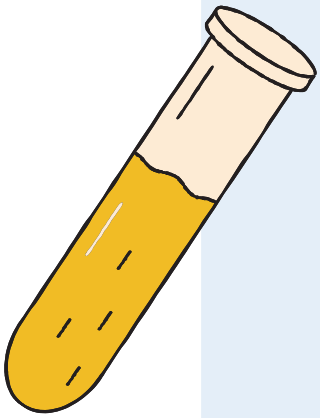
NIST – Gaithersburg, MD

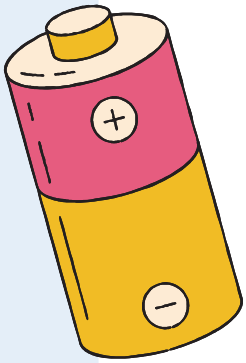
August 13-15, 2024

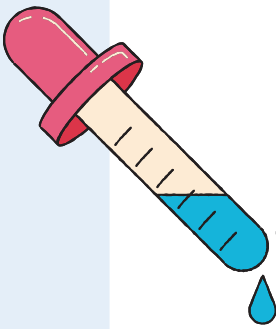
Name: Iman Syed	
Academic Institution: University of Maryland, College Park	**Major:** Mechanical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	NIST Center for Neutron Research (NCNR), Div. 610, Reactor Operations and Engineering
NIST Research Advisor:	Abdullah Weiss, Anil Gurgen
Title of Talk:	Verification of Thermal-Hydraulics Models for Nuclear Reactors with Plate-Type Fuels

Abstract:

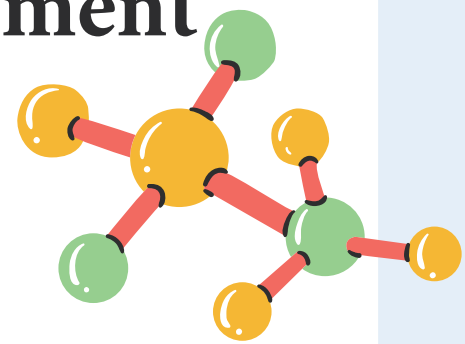
The NIST Center for Neutron Research (NCNR) houses the National Bureau of Standards Reactor (NBSR). The reactor has multiple coolant systems, including a primary coolant system with D_2O coolant. This coolant goes through channels inside the NBSR's core, absorbing heat from the fuel elements. This project focuses on modeling these channels with nuclear reactor thermal-hydraulics codes like PLTEMP. To accomplish this goal, geometric properties of the NBSR and thermal-hydraulic constants are obtained using existing CAD models of the reactor, previous documentation about the reactor, and manual computation. These parameters are written into an input file that the code will run. Then, the code returns an output file containing information like temperatures and safety margins. The temperatures consist of the fuel meat temperature, fuel cladding temperature, and coolant temperature. The output safety margins include the critical heat flux ratio (CHFR) and the onset of nucleate boiling ratio (ONBR). Other information is output as well. Then, these results are compared to actual data from the NBSR to verify that the thermal-hydraulics code accurately models the NBSR.







Physical Measurement Laboratory 2024



Summer Undergraduate Research Fellowship (SURF) - 2024 Participants

(in the order of the Colloquium schedule)

Physical Measurement Laboratory (PML)

Neeltje Kackar	Enhancing Firearm Toolmark Analysis with AI-Optimized Image Segmentation and Classification
Anthony Karoly	A Noise-Reduction Toroidal Transformer for Improvemetns in Magnetic Particle Imaging Technology
Mingxin Lei	Pressure Shifts and Broadening of Electromagnetically Induced Transparency in Rubidium Rydberg Atoms
Matthew Miller	Generation and Control of Magnetic Fields for the Laser Slowing of MgF Molecules
Jeremy Robin	Building a Portable Laser System for the Cold Atom Vacuum Standard
Matthew Boone	A Flexure Stage to Characterize Voice Coil Actuators in Tabletop Kibble Balances
Leiyla Brent	Optimization of the Calibration Source for a High-Resolution x-ray Spectrometer at the NIST EBIT
Zoe Fong	Measuring Dynamic Quantities of the Kibble Dynamic Force Reference
Julia Kanamine-Surrick	Advancing Magneto-Optical Spectroscopy for Quantum Materials Through Automation
Elina Lee	Time-of-flight and X-ray Spectra of a 0.7-Tesla mini-EBIT
Alan Zhu	A Tabletop Electromagnetic Force Measurement for Small Mass Measurement
Andrew Nupp	Substrate Optimization in Drop-on-Demand Inkjet Printing for Autoradiography Calibration Phantoms
Eva Rissanen	Building a Cryogenic Amplifier Means Chilling Out for Low Noise and High Sensitivity
Alisha Patel	Comparison of Yttrium-90 Radioactivity Measurements with TOPAS Simulations
Christina Addison	Development of Graphene Biosensors for Exosome Quantification in a Heart-on-a-Chip System
Nidhi Nagashankar	Cell Counting In Flow Cytometry
Shannon Newell	Using Solid State Silicon Nitride Nanopores to Assess the Effects of Irradiation on DNA
Addhyaya Sharma	Creating Silicon Vacancies in Silicon Carbide for Quantum-Enhanced Nanopore Sensing
Dinelka Jagoda	Expanding SI Educational Outreach Resources

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Christina Addison
Academic Institution:	Virginia Commonwealth University
Major:	Chemical and Life Science Engineering
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Complete undergrad and pursue a master's in cosmetic science
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Microsystems and Nanotechnology Division (681), Biophysical and Biomedical Group
NIST Research Advisor:	Derrick Butler and Darwin Reyes
Title of Talk:	Development of Graphene Biosensors for Exosome Quantification in a Heart-on-a-Chip System

Abstract:

Extracellular vesicles (EVs), particularly exosomes, play a critical role in cardiac repair following myocardial infarction (MI). However, the lack of understanding of the EV signaling mechanism hampers the advancement of EV-based therapeutics. This is exacerbated by the challenges in isolating and characterizing EVs. To address the latter issues, we employed graphene field-effect transistors (gFETs) as bioanalytical sensors to detect specific EVs. This sensor will ultimately be combined with a Heart-on-a-Chip (HoC) platform to detect specific EVs secreted by cardiomyocytes under normal and disease conditions.

In this work, we optimize the fabrication process by determining the parameters that ensures homogenous graphene for the fabrication of gFETS. The gFET fabrication process requires, first, etching the copper from a commercially available CVD-grown graphene. Then, utilizing a (Polymethyl methacrylate (PMMA)-assisted wet-transfer method, we transferred the graphene to a Si/SiO2 substrate to assemble the gFETs. The optimization primarily involves adjusting the dilution of the copper etchant and adjusting the duration of a UV-ozone pretreatment that has been previously found to result in cleaner graphene with improved electronic properties. In our process, it's crucial to dilute the etchant to 0.1 M concentration. Higher concentrations accelerate the etching process excessively, leading to the formation of oxygen bubbles that can cause cracks in the graphene, thereby compromising the quality of the final product. As for UV-ozone pretreatment, we have determined that exposing the sample for 30 minutes yields optimal results, preparing the surface effectively for subsequent processing steps.

Future work will include the fabrication of the gFETS and immobilization of specific antibodies for exosome capture and quantification. Experiments in the future involve testing antibody concentrations and benchmarking the gFET sensors using solutions with known exosome concentration.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Matthew Boone
Academic Institution:	University of Tennessee at Chattanooga
Major:	Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Ph.D. in Physics
NIST Laboratory, Division, and Group:	PML, Quantum Measurement Division, Fundamental Electrical Measurements Group
NIST Research Advisor:	Dr. Kumar Arumugam
Title of Talk:	A Flexure Stage to Characterize Voice Coil Actuators in Tabletop Kibble Balances

Abstract:

Flexures are thin metallic strips capable of bending within the elastic regime of a material but when arranged in unique patterns can serve as ultra-high precision guiding mechanisms. This technology has been utilized to development instruments such as QEMMS (Quantum Electro-Mechanical Metrology Suite), the successor to the NIST-4 Kibble balance which contributed to fixing the value of Plank's constant in 2019 and subsequently redefined the unit of mass, the kilogram, which was previously tied to a physical artifact located near Paris, France. The Kibble balance, a self-calibrating electromechanical instrument, operates using two modes: velocity mode and force mode. Combining the operations of these modes allows one to virtually compare mechanical power to electrical power, ultimately yielding a direct realization of mass via electrical measurements. At the heart of a Kibble balance is an electromagnetic coil with a total wire length L immersed in a magnetic field with flux density B. The mathematical product BL serves as the calibration factor necessary for realizing mass.

We have designed an aluminum, flexure-based stage to characterize the BL value of voice coil actuators used in tabletop Kibble balances. Using flexure mechanics and finite element analysis, we optimized the parameters of the flexures to allow the stage to move ±5 mm without reaching 1/3 of the yield stress of aluminum. A voice coil is used to drive the stage which can be feedback controlled using a fiber coupled Fabry-Perot interferometer that measures stage travel. The interferometer beam travels through a hole in the coil and magnet at the center of compliance to reduce Abbe error. To explore novel cost-effective displacement sensing options, we also use a knife edge sensor, optical gradient neutral density filter, and an encoder strip from ink-jet printers. Attached on the opposing side of the stage is a second voice coil whose BL profile can be characterized.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

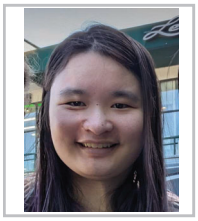
Name:	Leiyla Brent
Academic Institution:	Loyola University Maryland
Major:	Physics
Academic Standing (Sept. 2024):	Junior, Class of 2026
Future Plans (School/Career):	Graduate School, Doctorate/National Lab
NIST Laboratory, Division, and Group:	Physical Mesurement Lab
NIST Research Advisor:	Yuri Ralchenko
Title of Talk:	Optimization of the Calibration Source for a High-Resolution x-ray Spectrometer at the NIST EBIT

Abstract:

The Electron Beam Ion Trap (EBIT) at the National Institute of Standards and Technology (NIST) produces and traps highly charged ions that may be studied through their characteristic spectra. [1]. Applications for data from the EBITs include plasma spectroscopy for fusion, analysis of quantum electrodynamic and relativistic effects in atomic structure, and laboratory astrophysics. The Transition-Edge Sensor (TES) x-ray spectrometer uses 192 individual microcalorimeters that are optimized for the x-ray energies from about 500 eV to 8000 eV and achieve an energy resolution of 3.7 eV to 5.0 eV [2]. This combination of a wide spectral range and a high resolving power makes TES a unique tool for spectroscopy of highly charged ions.

The TES calibration process makes use of well-known x-ray lines produced by an external calibration source. A set of solid samples including Mg, Al, Si, KCl, V, Mn, Fe, and Cu are photoexcited by broadband x-ray emissions to produce characteristic K-alpha and K-beta lines that known to high precision. The long term goal is to measure these lines using the NIST Vacuum Double Crystal Spectrometer to connect their energy to the SI definition of the meter. The Microcalorimeter Analysis Software System (MASS) creates accurate energy spectra from the time-tagged, energy-calibrated x-ray data. We report a method for optimizing the calibration source to improve the TES calibration curve.

[1] J.D Gillaspy, Phys. Scr. T 71, 99 (1997)
[2] P.Szypryt et al., Rev. Sci Instru. 90, 123107 (2019)



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Zoe Fong		
Academic Institution:	University of Michigan	**Major:**	Mechanical Engineering, Violin Perf.
Academic Standing (Sept. 2024):	Senior (5th year undergrad)		
Future Plans (School/Career):	Industry and then graduate school		
NIST Laboratory, Division, and Group:	PML, Quantum Measurement Division, Mass and Force Group		
NIST Research Advisor:	Jared Strait		
Title of Talk:	Measuring Dynamic Quantities of the Kibble Dynamic Force Reference		

Abstract:

The Kibble Dynamic Force Reference (KDFR) is a novel device designed to generate a dynamic force with known amplitude, phase, and uncertainty. Unlike existing, traceable, portable dynamic force sources, the KDFR is a primary calibration device with operation based on a magnet, a coil of wire, and the Kibble principle, the same physics underlying the most accurate mass calibrations. This is a generic device concept with applications as an in situ dynamic load cell calibrator, a primary source of dynamic force for modal testing and material science, and an embedded, primary-calibrated device for critical sensing applications. The accuracy of the KDFR relies on characterization of the dynamic mechanical properties of the device components: stiffness and damping; acceleration, velocity, and displacement versus time and frequency. In this presentation, we will present experiments, modeling, and analysis to understand these dynamics and mechanical parameters as well as the best approaches for measuring them.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Dinelka Jagoda
Academic Institution:	University of Maryland, College Park
Major:	Computer Science
Academic Standing (Sept. 2024):	Dean's List
Future Plans (School/Career):	Earn B.S degree in Computer Science from UMD
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory (PML), Office of Weights and Measures (OWM), Metric Program
NIST Research Advisor:	Elizabeth Benham
Title of Talk:	Expanding SI Educational Outreach Resources

Abstract:

The International System of Units (SI), commonly known as the metric system, offers a straightforward and accessible framework for measurement. Early and consistent SI exposure is crucial in fostering familiarity and confidence among citizens. However, many educators are not fully familiar with effective SI teaching strategies. The NIST Office of Weights and Measures (OWM) Metric Program, is directed by law to promote the SI. While NIST education publications have historically focused on a middle school audience, the program is challenged to expand the current educational portfolio to younger students. Resources are currently delivered to educators, students, parents, and the general public through the SI Teacher Kit, the program website, and the NIST Educational STEM Resource Registry (NEST-R). My fellowship aims to bridge the existing gap by developing new materials and enhance current resources to support SI skill development in the early grades. As part of my responsibilities, I have gained experience in designing and developing interactive SI learning activities, the NIST peer review and publication process, and creating and evaluating webpage content. A primary project I worked on was the publication of "Estimating How Big: The Metric Estimation Game," and in developing the corresponding lesson plan and webpages. Accessibility through new webpages will ensure the resource is available to stakeholders for the 2024-2025 school season, national Metric Week, and the celebration of the 150th anniversary of the Treaty of the Meter. Furthermore, I have completed the development and design of a Metric Sports poster series to help students connect common metric measurements. In addition, my research has analyzed current adoption best practices of SI units in the healthcare, tourism, and hospitality industry sectors to leverage communication through new educational infographics and outreach posters. Through my multi-year SURF research experience, I have been able to contribute to the Metric Program's mission, by expanding K-12 educational outreach resources, addressing gaps in early SI education, and empowering U.S. educators to enhance SI literacy among younger students.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Neeltje Kackar

Academic Institution: College of William and Mary **Major:** Physics & Data Science

Academic Standing (Sept. 2024): Junior

Future Plans (School/Career):

NIST Laboratory, Division, and Group: PML, Division 685

NIST Research Advisor: Xiaoyu Alan Zheng

Title of Talk: Enhancing Firearm Toolmark Analysis with AI-Optimized Image Segmentation and Classification

Abstract:

In forensic firearm and toolmark analysis, generating objective comparison scores is crucial for establishing the scientific foundation of the discipline. Currently, the images which produce these scores are manually processed and labeled by human experts, which is time-consuming, subjective, and limits the speed of research progress. To overcome this challenge, I leveraged artificial intelligence to expedite a portion of the data pre-processing procedure. By utilizing AI for auto-segmentation ("where are the features?") and auto-classification ("what class is this feature?"), I was able to rapidly process a large database of measurement data, which is a significant enhancement to the efficiency, consistency, and speed of future firearm and toolmark research.

For this experiment, I utilized a dataset consisting of cartridge case images from Glock, Ruger, Smith & Wesson, and Sig Sauer firearms to analyze toolmarks, which are residual marks left on the cartridge case after it has been fired from a gun. The images were annotated using CVAT to provide the necessary training data for DDRNet-23, an image segmentation model. The annotations involved segmenting the image into different regions of interest and assigning the relevant class characteristics. To enhance the model's performance, I optimized several components: using the ELU activation function instead of ReLU, applying Tversky Loss as the loss function, and incorporating data augmentation techniques such as vertically flipping the image, random brightness/contrast adjustments, CLAHE, and FancyPCA. These optimizations significantly improved the mean intersection over union (mIoU) metric. The results indicate that the AI-driven approach markedly enhanced the speed and efficiency of assigning class characteristics to large populations of cartridge cases, facilitating more rapid advancements in firearm and toolmark analysis.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

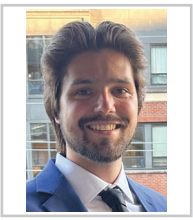
Name:	Julia Kanamine-Surrick
Academic Institution:	University of San Diego
Major:	Applied Mathematics
Academic Standing (Sept. 2024):	Graduated with Bachelor's in Applied Mathematics in May 2024
Future Plans (School/Career):	Taking a gap year to apply to graduate programs
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Quantum Measurement Division, Fundamental Electrical Measurements
NIST Research Advisor:	Dr. Angela Hight Walker
Title of Talk:	Advancing Magneto-Optical Spectroscopy for Quantum Materials Through Automation

Abstract:

When examining novel two dimensional (2D) materials, there is a need for new experimental capabilities. Our group's unique in the world magneto-optical instrumentation allows for Raman and photoluminescent (PL) spectroscopy with simultaneous control over the magnetic field, laser wavelength, temperature, and linear polarization. It also has spatial mapping and in-operando device transport capabilities. Automation of these features are controlled via LabVIEW programs. Expanding the current measurement capabilities will allow for the furthering of research into 2D quantum materials.

The existing LabVIEW code automates two pairs of polarizers and half-wave plates (HWPs), enabling the remote control of linear polarization of the incident laser and scattered light for magneto-optical spectroscopy experiments, which is critical to determine the symmetry of phonon modes (lattice vibrations) in Raman, and excitons in PL. My project will establish key measurement capabilities of circular polarization and power dependence, increasing the experimental capabilities of the group. Circular polarization will be achieved by replacing the HWP for the incident laser light with a quarter-wave plate (QWP), enabling the handedness control and helicity selection. Additionally, a wheel composed of 12 neutral density filters will be added and controlled for power dependence experiments, providing additional insight into the effect of laser power levels of various visible wavelengths on the sample being tested.

In order to test the added automation capabilities, a two dimensional (2D) chiral perovskite will be examined. Under circular polarization, chiral 2D perovskites exhibit a strong optical response depending on the chirality, making it a good candidate for testing the new automation.



SURF Student Colloquium

NIST – Gaithersburg, MD

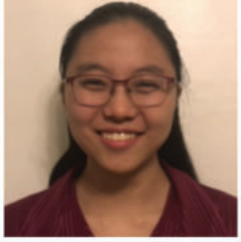
August 13-15, 2024

Name:	Anthony Karoly
Academic Institution:	University of Maryland
Major:	Physics
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Pursue a PhD in physics
NIST Laboratory, Division, and Group:	Physical Measurement Lab (PML), Sensor Science Division, Remote Sensing Group - 685.04
NIST Research Advisor:	Thinh Q. Bui
Title of Talk:	A Noise-Reduction Toroidal Transformer for Improvemetns in Magnetic Particle Imaging Technology

Abstract:

Magnetic Particle Imaging (MPI) is a cutting-edge 3D imaging technique currently under development at the National Institute for Standards and Technology (NIST) as part of the Thermal Magnetic Imaging and Control (Thermal MagIC) project. MPI uses magnetic fields for remote detection of iron oxide magnetic nanoparticle tracers embedded inside an object or specimen for real-time, 3D imaging. The central goal of Thermal MagIC is to use MPI for in situ 3D temperature measurement and control by exploiting the temperature sensitivity of engineered magnetic nanoparticles. Currently, temperature is commonly measured using traditional resistance thermometers or by optical methods that are limited at surfaces; Thermal MagIC looks to revolutionize this process. Since MPI uses magnetic fields to perform remote readout of the the magnetization of embedded nanoparticles, it is possible to determine the temperature of the whole 3D object, and not just at the surface.

Temperature measurements using magnetic nanoparticle requires sensitive electronics for generating excitation fields for driving magnetic nanoparticles. Further advancements for this application require increasingly complex electronic circuitry to improve sensitivity. A noise-reduction strategy currently under development is that of a 1:1 toroidal transformer intended to minimize the DC bias and other spurious noise sources present in amplifier electronics used for producing the MPI excitation field. Such a transformer poses a challenge to develop, however, as the electromagnets are driven at such high voltages that an iron-core transformer would saturate, greatly hindering its usefulness. Consequently, an air-core transformer doesn’t experience this issue; however, air-core transformers lack a medium to concentrate the flux from the primary coil through the secondary coil, resulting in weak magnetic coupling between the input and output of the transformer, causing attenuation of the signal by several orders of magnitude. Therefore, further exploration of various transformer designs is underway to improve drive electronics for MPI.



SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Elina Lee		
Academic Institution:	Carnegie Mellon University	**Major:**	Environmental Engineering & Stat ML
Academic Standing (Sept. 2024):	Sophomore		
Future Plans (School/Career):	Graduate degree and career in data science		
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Quantum Measurement Division, Atomic Spectroscopy Group		
NIST Research Advisor:	Dr. Joseph Tan		
Title of Talk:	Time-of-flight and X-ray spectra of a 0.7-Tesla mini-EBIT		

Abstract:

A portable, miniature Electron Beam Ion Trap (mini-EBIT) was recently constructed at NIST. Its performance is illustrated by observing the highly charged ions produced in the EBIT, as well as the light emitted when the ions decay from excited states. In particular, I will discuss the Python program used to digitalize the time-of-flight spectra of the ion signals extracted from the mini-EBIT. New features include inputting different file formats and saving charge states of interest to a new or existing spreadsheet. This revised program facilitates the analysis of time-of-flight spectra to identify charge states due to injected gases separately from those due to residual background gases. X-ray emissions due to neon gas injections were also observed with a silicon drift detector and were analyzed to study the role of the electron beam.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Mingxin Lei
Academic Institution:	University of Maryland College Park
Major:	Chemistry and Math
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	PhD in Physical Chemistry
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Sensor Science Division, Fundamental Thermodynamics Group
NIST Research Advisor:	Eric Norrgard
Title of Talk:	Pressure shifts and broadening of electromagnetically induced transparency in rubidium Rydberg atoms

Abstract:

Rydberg atoms, with their unique properties and sensitivity to external fields, offer promising avenues for precise sensing of radio frequency fields, blackbody radiation, and more. Due to their large electric dipole moments, they are highly sensitive to external electric fields and electromagnetically induced transparency (EIT) traces are used in precise measurements of RF fields. However, this ultra-sensitivity also further enhances perturbations due to background gases and other contaminants. We investigate the interactions between Rydberg atoms and background gases such as Ar, He, N2, and Ne to study the effect of these contaminant gases on the quality of EIT line shapes in vapor cells. EIT signals are monitored in order to record pressure shifts and broadening parameters, which aid in characterizing the interactions between Rydberg atoms and target gases under a controlled environment. This research aims to contribute to the development of high-precision sensors based on atomic vapor cells with Rydberg atoms, including advanced microfabrication techniques. This study diagnoses poorly performing vapor cells and the results can be generalized for all possible contaminant gases.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Matthew Miller
Academic Institution:	Brigham Young University
Major:	Physics
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Pursue a PhD in physics, then a career in experimental physics research
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Sensor Science Division, Fundamental Thermodynamics Group
NIST Research Advisor:	Dr. Nickolas Pilgram
Title of Talk:	Generation and Control of Magnetic Fields for the Laser Slowing of MgF Molecules

Abstract:

Laser cooled and trapped polar molecules are an emerging platform for a variety of precision measurement and metrology applications. The cold molecular samples needed for these applications are typically generated using a magneto-optical trap (MOT), an apparatus which uses lasers and magnetic fields to cool and trap atoms or molecules. In order to capture molecules in a MOT, they must first be slowed to velocities below the capture velocity of the MOT. One obstacle to laser slowing molecules is the decay of excited molecules into dark Zeeman sublevels, which prevents them from scattering additional photons from the slowing laser. This problem can be addressed by applying a magnetic field, which causes the Zeeman sublevels to precess back into bright states. Here, we report on the development and testing of a magnetic slowing coil for the remixing of Zeeman dark states when laser slowing MgF molecules. Additionally, the development of fast switching circuits, which allow the magnetic coils to be quickly turned off, is discussed. Finally, we report on the progress of the laser slowing of MgF molecules.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Nidhi Nagashankar
Academic Institution:	University of Maryland, College Park
Major:	Bioengineering and Computer Science
Academic Standing (Sept. 2024):	Sophomore in Undergraduate
Future Plans (School/Career):	I hope to continue research in interested disciplinaries related to Bioengineering and Computer Science and pursue higher education post-undergrad.
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Microsystems and Nanotechnology Division, Biophysical and Biomedical Measurement Group
NIST Research Advisor:	Dr. Gregory Cooksey
Title of Talk:	Cell Counting In Flow Cytometry

Abstract:

Flow cytometers enable scientists to analyze the composition and properties of individual cells and beads, by collecting light emitted or scattered by biomarkers in provided samples. However, uncertainties associated with counting and quantifying biomarkers are not yet well defined. This project aims to better quantify uncertainty in cell and bead counting by creating an absolute counting reference used to validate the accuracy of object counting by flow cytometers. Our methods rely on tracking a known quantity of objects in a sample well through a counting process, therefore determining uncertainties added in various steps of the protocol.

First, we use a fluorescence-activated cell sorter (FACS) to create a count concentration standard by depositing a known number of beads into a measured volume. This count is validated by microscopy and image processing. Next, half of the sample is injected into a flow cytometer for counting. Finally, the beads remaining in the original sample are re-counted to compare to the cytometer count. The "missing" objects enable an estimate of counting accuracy.

In my project, I am applying this method to study how spiking in this bead standard to an unknown sample can be used to estimate the count in an unknown sample. Establishing these measurements will help improve specifications on biological products, such as cellular therapies and estimates of quantities like the number of cancer cells in blood samples.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Shannon Newell
Academic Institution:	Boston University
Major:	Biomedical Engineering
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Graduate school
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Division 681, Biophysical and Biomedical Measurement Group
NIST Research Advisor:	Joseph Robertson
Title of Talk:	Using solid state silicon nitride nanopores to assess the effects of irradiation on DNA

Abstract:

Accurate and quick methods for analyzing the effects of radiation on DNA are necessary to understand its impact on people, such as that faced during cancer treatment or as an occupational hazard, yet current methods of dosimetry are time-consuming and relatively expensive. Solid state nanopores, defined by fabricating single-digit nanometer pores in ~10 nm thick silicon nitride membranes, offer an efficient and cheap solution for nucleic acid characterization. After a straightforward fabrication process through dielectric breakdown, these nanopores provide a high throughput, allowing us to detect and characterize thousands of DNA molecules in minutes. The pore is situated between two fluid reservoirs containing electrolyte solutions, and ionic current through the pore is measured when an applied potential is placed across the membrane. DNA is driven through the pore interrupting the current as 'resistive pulses'. This signal is then used to measure the size of DNA fragments with a resolution of 10s of base pairs. Utilizing these qualities, we are quantifying radiation induced double strand scission reactions, which results in a dose-response curve to provide retrospective biodosimetry.

However, there is often vast variability in pore quality and resolution, which only becomes clear after experiments. Noise characteristics of pores, such as ionic current noise and 1/f noise, as found from power spectral density, has been shown to be governed by a pore's geometry and chemistry, and through evaluation of these characteristics, we hope to assess pore quality prior to experiments in order to prevent wasteful use of sample.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name: Andrew Nupp	
Academic Institution: Yale University	**Major:** Physics/Math
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Graduate School
NIST Laboratory, Division, and Group:	PML, Radioactivity Division, Radioactivity Group
NIST Research Advisor:	Denis Bergeron
Title of Talk:	Substrate Optimization in Drop-on-Demand Inkjet Printing for Autoradiography Calibration Phantoms

Abstract:

2D autoradiography is an important tool for measuring the biodistribution of radiopharmaceuticals designed to target specific cells. Achieving accurate measurements requires calibration phantoms with precisely known activity and high spatial resolution. This need is addressed using advanced drop-on-demand inkjet printing techniques to deposit picoliter volumes of radioactive solutions with activity traced to liquid scintillation measurements. However, the influence of substrate properties on printing quality is not yet fully understood, driving a need for characterization of surface interactions between the solutions and various substrates. To achieve this, microscopy and contact angle measurements were used to analyze surface chemistry, while phenomena at the solution/substrate interface such as surface migration, etching, and the coffee ring effect were studied to account for differences in the deposition outcome. These investigations provide the foundation for tailoring substrates to optimize the resolution of drop-on-demand inkjet printing for autoradiography calibration phantoms.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Alisha Patel
Academic Institution:	University of Maryland, Baltimore County
Major:	Biochemistry & Molecular Biology
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	Enroll in a PharmD Program
NIST Laboratory, Division, and Group:	Physical Measurement Laboratory, Radiation Physics Division, Radioactivity Group
NIST Research Advisor:	Brittany Broder
Title of Talk:	Comparison of Yttrium-90 Radioactivity Measurements with TOPAS Simulations

Abstract:

Radiopharmaceuticals play a crucial role in both diagnosing and treating cancer. Knowing the activity ensures the patient receives an effective treatment dose, potentially mitigating negative toxicity. Many instruments can be used to measure the activity of a radioactive source. The ionization chamber is an instrument that contains a fill gas in which radiation emissions can ionize the gas. From this ionization, the electrodes in the gas produce an electrical current proportional to the source activity. The gamma well counter is another device used to measure the activity of a source. It consists of a sodium iodide scintillation crystal with an insert well, in which a radioactive sample is placed. As the source decays, the emissions interact with the crystal to produce light that can be read out as a signal and correlated to the activity. The recently developed micro-dose calibrator also uses scintillation crystals to produce photons and consists of a segmented, well-type geometry. Due to this geometry, it can measure smaller doses on the 'micro' curie or kBq range, which are read out through photomultiplier tubes paired to each of the crystals. Yttrium-90 (Y-90, t[1/2]=2.65 d) is a radionuclide that emits beta particles and is primarily used to treat liver cancer. Y-90 is a favorable therapeutic due to its short range and high energy deposition, which selectively targets the tumor. There are difficulties when modeling and measuring the activity of Y-90 because instrument response must rely on bremsstrahlung interactions. Zirconium-89 (Zr-89, t[1/2] =3.27 d) is a radionuclide often used for cancer imaging. Its relatively long half-life means it can be labeled to larger, slower imaging vectors and used to image cancer over time. The positron emission is short-ranged compared to other imaging radionuclides, rendering high resolution imaging. In this project, the Geant4-based Monte Carlo Program TOPAS is used to model the Vinten 671 Ionization Chamber, Gamma Well Counter, and Micro-dose Calibrator. Different source geometries were also stimulated to observe instrument response. Sources were measured experimentally with each of the aforementioned instruments and the results were compared.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Eva Rissanen
Academic Institution:	Appalachian State University
Major:	Physics w/ Astronomy concentration
Academic Standing (Sept. 2024):	Senior
Future Plans (School/Career):	In the future I'd like to go to grad school to continue pursuing my studies in Physics!
NIST Laboratory, Division, and Group:	PML, Nanoscale Device Characterization Division, Atom Scale Device Group
NIST Research Advisor:	Dr. Josh Pomeroy
Title of Talk:	Building a Cryogenic Amplifier Means Chilling Out for Low Noise and High Sensitivity

Abstract:

I characterized transistors and utilized them in a transimpedance amplifier that functions at cryogenic temperatures. Measurement electronics at room temperature have components that are far away from each other, creating excess noise that impacts data quality. Successfully building and operating the amplifier at 4 K would greatly reduce the noise and clean up the data. Transistors are essential for this amplifier, but some transistor functions are temperature dependent. I measured transistors at room temperature and at 4 K to characterize any changes in gate current, threshold voltage, and transimpedance. Once a transistor is selected and the amplifier is built, it'll be measured at room temperature and at 4 K to see if it meets the desired parameters which include: low noise, a power dissipation of less than 10 uW, a gain of 10 V/A or higher, and a bandwidth greater than 100 kHz.

SURF Student Colloquium

NIST – Gaithersburg, MD August 13-15, 2024

Name: Jeremy Robin

Academic Institution: Washington University in St. Louis | **Major:** Physics and Computer Science

Academic Standing (Sept. 2024): Senior

Future Plans (School/Career): Not Sure

NIST Laboratory, Division, and Group: PML, Sensor Sciences Division, Fundamental Thermodynamics Group

NIST Research Advisor: Stephen Eckel

Title of Talk: Building a Portable Laser System for the Cold Atom Vacuum Standard

Abstract:

The cold atom vacuum standard (CAVS) is a novel, NIST-pioneered technology to measure pressures in ultra-high vacuum without the need for calibration. The CAVS system works by loading a cloud of roughly 1 mK lithium atoms into a conservative magnetic trap within the vacuum chamber of interest. When a background gas molecule collides with a lithium atom in the trap, it is extremely likely to be ejected from the trap. Crucially, the rate of ejection of lithium is related to the density or pressure of the background gas molecules and the cross section for a collision, the latter of which can be calculated from first principles and effectively making the CAVS calibration-free.

To both get the lithium atoms into the magnetic trap and count the atoms that remain in the magnetic trap, we use a co-located magneto-optical trap (MOT). A MOT uses laser light from several angles combined with a magnetic field gradient cool and trap atoms into a small region of space. For the magneto-optical trap to work, the laser frequency must be precisely to be slightly lower than the $2\,^2\mathrm{S}_{1/2}(F=2) \rightarrow 2\,^2\mathrm{P}_{3/2}(F=3)$ cycling transition frequency in ^{7}Li. This laser cause moving atoms to be excited to a higher energy level. When the lithium atoms decays back to the ground state, they fluoresce, which both cools the atoms and can be used to count the atoms in the trap.

In the past couple years, a portable version of CAVS based on a grating MOT was developed and is almost ready to travel around to other labs. In order to finally make it out of the lab, a portable laser system is needed. My work this summer is focused on building this laser system. The portable laser system will lock the laser's frequency to the transition that causes the lithium atoms to fluoresce in the CAVS experiment using a separate lithium vapor cell to probe the desired transition and to send information back to the laser system to correct the laser's frequency. An acousto-optic modulator is used to tune the exact frequency offset needed for efficient laser cooling. An electro-optic modulator is also used to generate the necessary "repump" light on the $2\,^2\mathrm{S}_{1/2}(F=1) \rightarrow 2\,^2\mathrm{P}_{3/2}(F=2)$ transition. All these components, together with their control electronics, were assembled on a standard 19" equipment rack that can be rolled around from lab to lab. Once assembled, we tested the portable system and found that we could indeed make a MOT and operate the p-CAVS.

SURF Student Colloquium

NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Addhyaya Sharma
Academic Institution:	The City College of New York (CUNY) — **Major:** Physics
Academic Standing (Sept. 2024):	Graduate student
Future Plans (School/Career):	PhD in Quantum Engineering
NIST Laboratory, Division, and Group:	PML, Division 681, Photonics and Optomechanics Group
NIST Research Advisor:	Dr. Henri Lezec & Dr. Joseph W. Robertson
Title of Talk:	Creating Silicon Vacancies in Silicon Carbide for Quantum-Enhanced Nanopore Sensing

Abstract:

Silicon Carbide (SiC) is a wide band gap semiconductor known for its excellent thermal and electrical properties. In recent years, color centers in SiC have shown great promise for quantum sensing due to the convenient optical initialization and control of their electronic spin states. This study aims to integrate these color centers into a nanopore sensor, which detects and characterizes single molecules (i.e., proteins, nucleic acids) through changes in ionic current as they are driven through a pore. The integration of color centers into this system induces a change in the optical signal due to the spin sensitivity of the system as molecules interact with the pore, which can be studied alongside the electrical signal to provide details about the size and chemistry of the molecule.

In this study, we test the feasibility of creating silicon vacancies in 4H-SiC around a nanopore by utilizing a Gallium-based focused ion beam and, concurrently, a Xenon Difluoride (XeF2) assisted electron beam etch. The samples are characterized by room and low-temperature photoluminescence measurements using a standard scanning confocal setup, along with g^2 correlation measurements using a Hanbury-Twiss setup to confirm the single-photon emitter characteristics of the color centers.

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NIST – Gaithersburg, MD

August 13-15, 2024

Name:	Alan Zhu
Academic Institution:	University of Pennsylvania
Major:	Physics, Computer Science, Robotics
Academic Standing (Sept. 2024):	Junior
Future Plans (School/Career):	Pursue a PhD in physics or robotics
NIST Laboratory, Division, and Group:	PML, Quantum Measurement Division, Fundamental Electrical Measurements Group
NIST Research Advisor:	Richard L. Steiner, Gordan A. Shaw
Title of Talk:	A Tabletop Electromagnetic Force Measurement for Small Mass Measurement

Abstract:

In 2019, the definition of mass in SI units was changed to depend on Planck's constant and the speed of light. This introduced a new paradigm for precision mass metrology utilizing electromagnetics. In particular, for smaller masses (~1 mg), the mass measurement group at NIST currently employs an electrostatic approach involving voltage and capacitors. We now pursue a tabletop, electromagnetic approach utilizing current and two concentric solenoids.

This process can be broken down into two steps. The first step, and the focus of my work over the summer, is to accurately measure the mutual inductance between the solenoids as a function of their z (coaxial) separation. To do this, we passed an AC current through one solenoid and measured the induced voltage in the other. With the voltage, we can then calculate the mutual inductance as $M=\varepsilon/(I\omega)$ where M is the mutual inductance, ε is the induced voltage, I is the input current, and ω is the input frequency. After enough datapoints were collected, we fit a best fit line and took the slope as our dM/dz.

To reach the desired precision of this measurement, each of the multimeters and AC signal sources also need to be calibrated. A table of correction factors along with their uncertainties will be created to account for the gain on each of the devices. Despite preliminary calculations suggesting the force between the solenoids could be on the nanonewton scale, initial voltage measurements promisingly show repeatability up to 4 digits at the microvolt level with a resolution of 6 digits. This is good news for our goal of ultimately reaching a ±100 ppm uncertainty when using this technique for 1 mg mass calibrations.