ENABLING TECHNOLOGIES & INNOVATION CONSORTIUM

2020 Newsletter

Georgia Tech | ETI

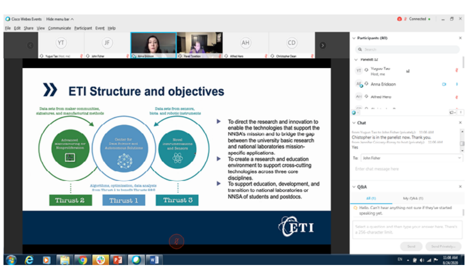
MESSAGE FROM THE DIRECTOR

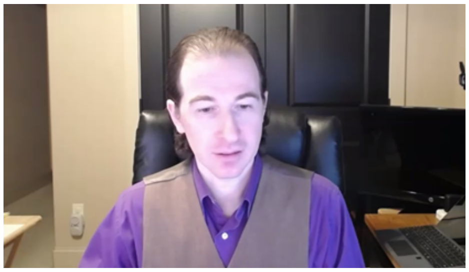
Dr. Anna Erickson, Consortium Director

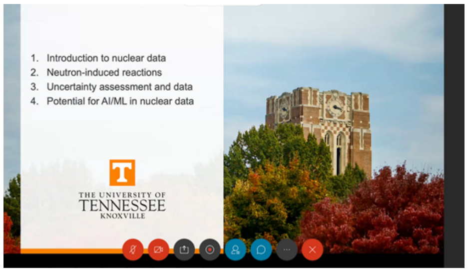
Innovation is exploration of uncertain and unfamiliar space. In our Consortium name, we place a special emphasis on innovation through our research, education of the next generation of scientists, and broad outreach activities. The past year was certainly a year of new and uncertain experiments, from starting the collaboration up to complete transition to online laboratory work, to learning how to teach diverse subjects in the pressure of Zoom meetings. Luckily, we are united by a common trait—being comfortable with learning new things and experimenting. Reflecting on the achievements of the past year, I want to highlight a combination of creativity, resourcefulness, and discipline leading the success of various initiatives. Despite the isolating nature of the past six months, we witness new collaborations forming across ETI, connecting more labs and universities through research and education. Our all-virtual summer meeting highlighted research conducted by young investigators at the universities and by our national lab partners, spanning basic science and applications in all three thrust areas. The roundtable discussion presented an opportunity for the students to learn about transitioning to the national laboratories, getting their first grants, and collaborating in interdisciplinary environments. At the end of the summer, we hosted our first summer school, focused on data science and its application in nonproliferation. Being virtual, the school attracted over a hundred participants, from high schools to lab researchers. Close collaboration between national laboratories and universities is fundamental to successful ETI activities.

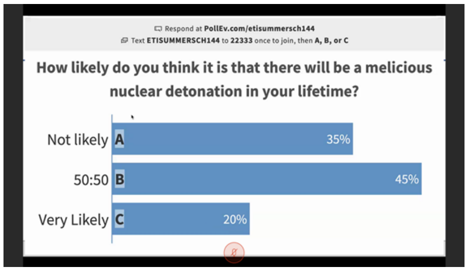
What does the next year look like? Things did not exactly go as expected in the first year, and we cannot assume that "back to normal" is within a close reach. We witnessed our innovation being crippled by isolation, but the key element of our success was finding a balance between exploration and resilience. Going forward, we will take advantage of our experience by opening the research and education opportunities to wider communities (yes, we are becoming very comfortable with filming our presentations and posting them online), becoming more efficient with our time and resources (hybrid meetings and conferences, anyone?), and, most importantly, being open for constant transformation in the way we conduct our daily activities.

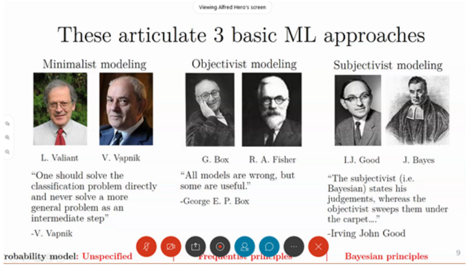
Thank you for your contribution to the team, which will hopefully live and thrive beyond the ETI lifespan. I look forward to the continuation of this fruitful and stimulating collaboration!

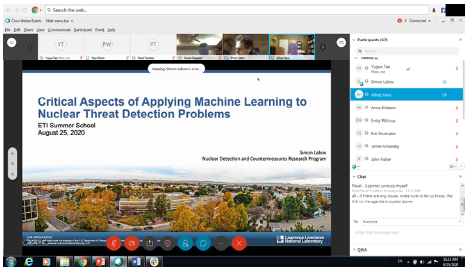












ETI SUMMER SCHOOL 2020

Two-Part Workshop on Data Science and Engineering

The ETI Consortium organized and hosted the first part of the two-part summer school 2020 focused on data science and engineering. This summer school is the first in the annual summer school series that will be organized and hosted by ETI every year.

Our objective for the summer school 2020 is to provide attendees with an opportunity to immerse themselves into the world of data science and engineering in the context of the ETI applications. Part 1 was hosted virtually. We are planning to host Part 2 at Georgia Tech.

The agenda for Part 1 consisted of four modules on data science offered daily, complemented by four lectures on engineering applications focused on nuclear security and nonproliferation:

- **Modules:**

1. Fundamentals of Data Applications, Steven Biegalski, Georgia Institute of Technology
2. Computational Machine Learning, Alfred Hero, University of Michigan
3. Bayesian Modeling and Inference, John Fisher, Massachusetts Institute of Technology
4. Data Science for Safeguards, Karl Pazdernik, Pacific Northwest National Laboratory

- **Lecturers:**

1. Nuclear-Data Analytics, Vladimir Sobes, University of Tennessee, Knoxville
2. Critical Aspects of Applying Machine Learning to Nuclear Threat Detection Problems, Simon Labov, Lawrence Livermore National Laboratory
3. Data Streams and Analysis, Will Ray, Oak Ridge National Laboratory
4. Radiation Detection Data Analytics, James Ghawaly, Oak Ridge National Laboratory

The nonproliferation challenges and the role of data science and engineering were showcased to the attendees through lectures by experts from universities and national laboratories. Teaching modules offered introduction on data science methods and included hands-on illustrations and tutorials covering applications of data science and engineering for nonproliferation. This combination of lectures that discussed existing challenges coupled with hands-on experiences in modules allowed attendees to boost their fundamental knowledge and hone their skills under the constraints of a single-week program.

The summer school was attended by 214 participants from academia and national laboratories as well as one attendee from a high school. Thirty-seven percent of participants estimated their level as "beginner," while 12% assessed themselves as being at "advanced" and 47% assessed themselves as being at "intermediate" levels. University participants included undergraduate, graduate M.S., and graduate Ph.D. students as well as post-doctoral researchers.

Participants offered these comments:

- The material was very interesting and informative, and the speakers gave a thorough and well-explained review of complex concepts.
- I enjoyed the safeguard and detector lectures.
- Getting a great crash course in ML/statistics that can help any researcher, with the added benefit of real examples I can play around with on my own.
- I enjoyed the depth of lecture material and also the range of topics covered.

DR. JENIFER SHAFER

Sabbatical at LANL: March–August 2020

Dr. Jenifer Shafer spent her sabbatical at Los Alamos National Laboratory (LANL) from March to August 2020. While at Los Alamos, some lab and onsite interactions were limited, courtesy of COVID-19, from April through June. Toward the end of June, Dr. Shafer was able to be onsite with much more regularity.

Her time was spent in the Chemistry division interacting with the Nuclear & Radiochemistry (C-NR) and the Isotopes, Inorganic & Analytical Chemistry (C-IIAC) groups. Collaborations were enriched with Todd Bredeweg regarding the Geological Survey TRIGA® Reactor (GSTR) for fission product measurements, and a joint Laboratory Directed Research and Development Program (LDRD) proposal at LANL is planned for this upcoming December. Measurements at the Device Assembly Facility (DAF) using GODIVA were planned for July, but these were postponed until October. Dr. Shafer learned more about the separations processes used for long-lived fission products and the broader consortium of fission product yield measurements ongoing at Pacific Northwest National Laboratory (PNNL) using the dense plasma focus (DPF) machine, the critical assemblies at the DAF, and the 88” cyclotron at Berkeley. A manuscript based on fission product work arising from this effort is planned for submission this year, “Quantifying Abundances of Long-Lived ^{155}Eu and ^{151}Sm Fission Products Using g- and Liquid Scintillation Counting Spectroscopies.”

Dr. Shafer noted that resources at LANL were also useful for establishing a collaboration with Lawrence Livermore National Laboratory (LLNL) for forensics investigations of post-detonation debris. Capt. Michael Parker will be joining Dr. Shafer’s research group this fall courtesy of Air Force sponsorship of his Ph.D., and his Ph.D. will focus on forensics of post-detonation debris.

Highlights:

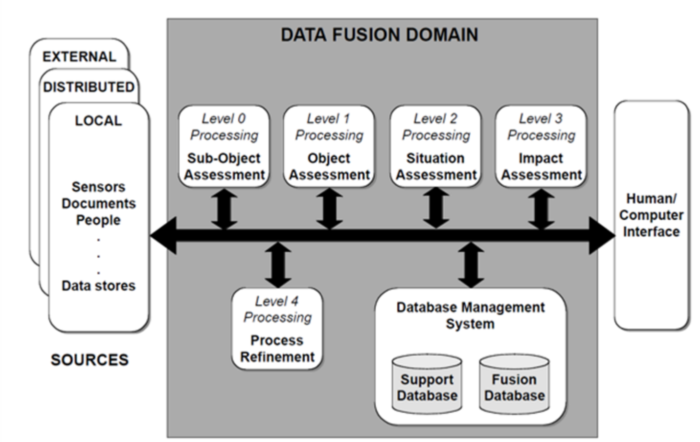
- A manuscript on fission product measurements is planned for submission for fall of this year: Brian A. Arko, Kenneth R. Ashley, Scott M. Bowen, Warren J. Oldham Jr., Angela C. Olson, Stosh A. Kozimor, Ann R. Schake, and Jenifer C. Shafer. “Quantifying Abundances of Long-Lived ^{155}Eu and ^{151}Sm Fission Products Using g- and Liquid Scintillation Counting Spectroscopies,” *Talanta* (In progress).

- Dr. Shafer was able to develop fission product work with the DAF.

- A capability for measuring intermediate-lived fission products is in development at the GSTR with Los Alamos.

ETI RESEARCH SPOTLIGHTS

Thrust Area 1

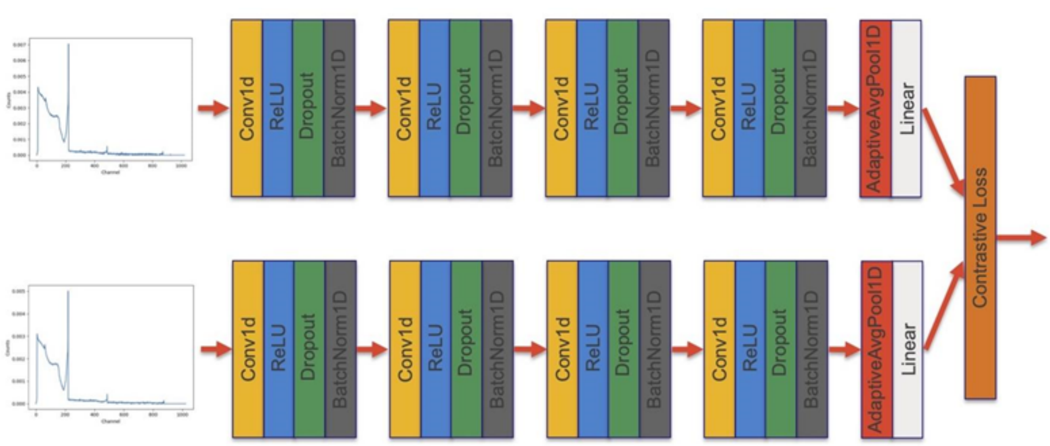


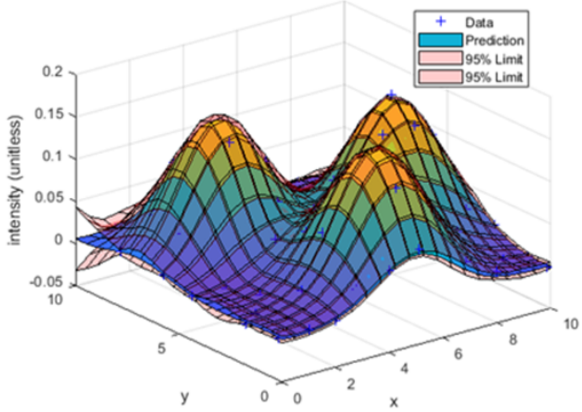
1. Jordan Stomps (UW): *Identifying data streams valuable to collaborative intelligence.*

The mission of the Consortium for Enabling Technologies and Innovation (ETI) as defined in its proposal is to develop methods "that support the NNSA's mission and to bridge the gap between the university basic research and national laboratories mission-specific applications." In reaching this goal, it is important to first identify potential opportunities for collaboration and analysis. A data-use manual has been created that will serve as a centralized list of available sources that could be valuable to the efforts of ETI. This manual should foster connections between university and national laboratory partners by highlighting data sources at different levels of complexity and sensitivity. As a living document, newly identified or emerging data streams can be included so that the evolving manual serves as a centralized location to support ETI researchers. As such, researchers are encouraged to help build the manual by providing sources that may be identified but missing from the data manual.

2. Eric Shumaker (UM): *Spectral unmixing and prediction with generative probabilistic graphical models.*

Many general purpose algorithms have attempted to identify radiological sources in gamma ray spectra. In this project, undertaken while I was an intern at Los Alamos National Laboratory this past summer under the guidance of Dr. Jacob Stinnett, a twin neural network architecture is trained to identify radiological sources from gamma ray spectra by comparing each input spectra to other spectra from a known library. The known library used for network training consists of simulated spectra from 53 different radiological sources. During spectra simulation, many factors such as background radiation, detector distance, detector measurement time, source height, and source shielding were taken into account to generate training data to closely match that of gamma ray spectra found in real world measurements. The preliminary accuracy of the twin network architecture in combination with the large number of radiological sources contained in the simulated training set supports the generality of this approach.





3. Sam Kemp (GT): *Optimal UAV Trajectory Planning for Radiological Search.*

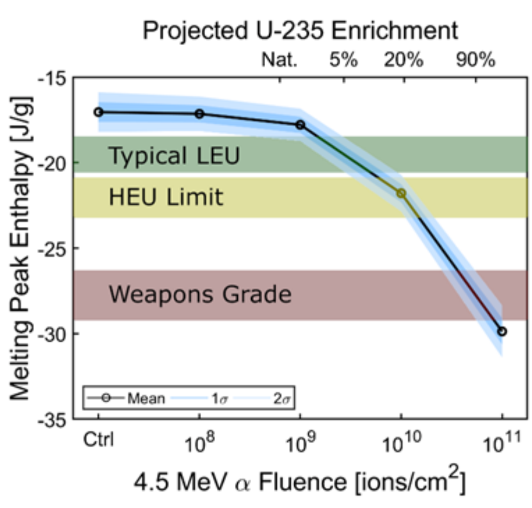
Radiological search and mapping missions are typically performed by human agents or, in some cases, remotely piloted vehicles. Because radiation intensity falls off with distance squared, effective radiation scans with small, low cost detectors must be performed in close proximity to the ground and nearby obstacles. As a result, human operators are typically closely involved in operating vehicles to ensure safety. Our work involves development of multi-agent information-driven active search algorithms that can identify areas of interest and effectively cover the search area much quicker than humans or human-piloted vehicles. While obstacles lengthen search times in general, if a multi agent search were able to dynamically assign agents (through dynamic resource allocation) to areas with high obstacle density, it could lead to significant improvement in search times. The goal of this work is to develop algorithms that combine information-driven active search and dynamic resource allocation to rapidly perform radiological search and mapping, with significantly reduced time to completion compared to human-piloted missions.

ETI RESEARCH SPOTLIGHTS

Thrust Area 2

1. Rachel Connick (MIT): *Measurement of low-dose irradiation effects in PTFE using differential scanning calorimetry.*

A key step in both nuclear energy and nuclear weapon programs is the isotopic enrichment of uranium, but it is difficult to determine whether the use of the uranium will be for commercial (low enrichment or LEU) or military (high enrichment or HEU). Natural uranium is not very radioactive to begin with, but as it is enriched, it becomes slightly more radioactive. This radiation emitted by the uranium damages surrounding materials, of which we focus on polytetrafluoroethylene (PTFE) as it is used in gaskets at enrichment plants. We can quantify this damage using differential scanning calorimetry (DSC). We measure heat absorbed when melting several irradiated PTFE samples because irradiation changes the melting enthalpy. The attached graphic shows that there are clear differences in the DSC signature obtained depending on the percentage enrichment of the uranium. Based on my measurements, PTFE is sufficiently sensitive to radiation such that, if it were exposed to radiation emitted by enriched uranium, its forensic signature could be used to deduce the purpose of the enrichment procedure: energy or weapons.

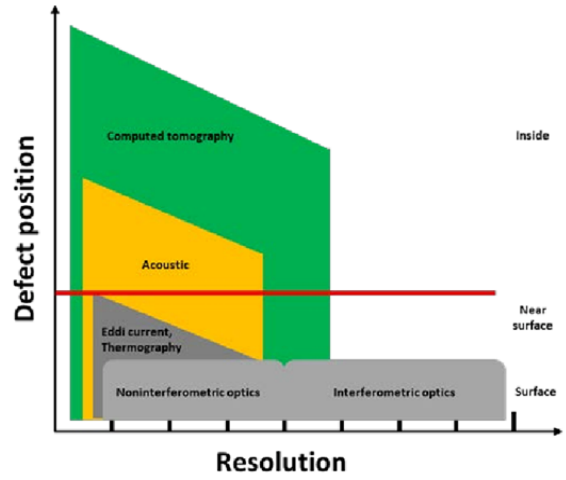


Presentations:

Connick, R.C., Short, M. P., Kemp, R.S. (2019, November 25-27). Investigating radiation damage in polymers for nuclear forensic applications [Conference presentation]. 4th International Flash DSC Conference, Zurich, Switzerland.

Connick, R. C., Hirst, C. A., So, K., Short, M. P., & Kemp, R. S. (2019, October 6-10) Measurement of lowdose irradiation effects in PTFE using differential scanning calorimetry [Conference presentation]. MiNES 2019, Baltimore, MD, USA.

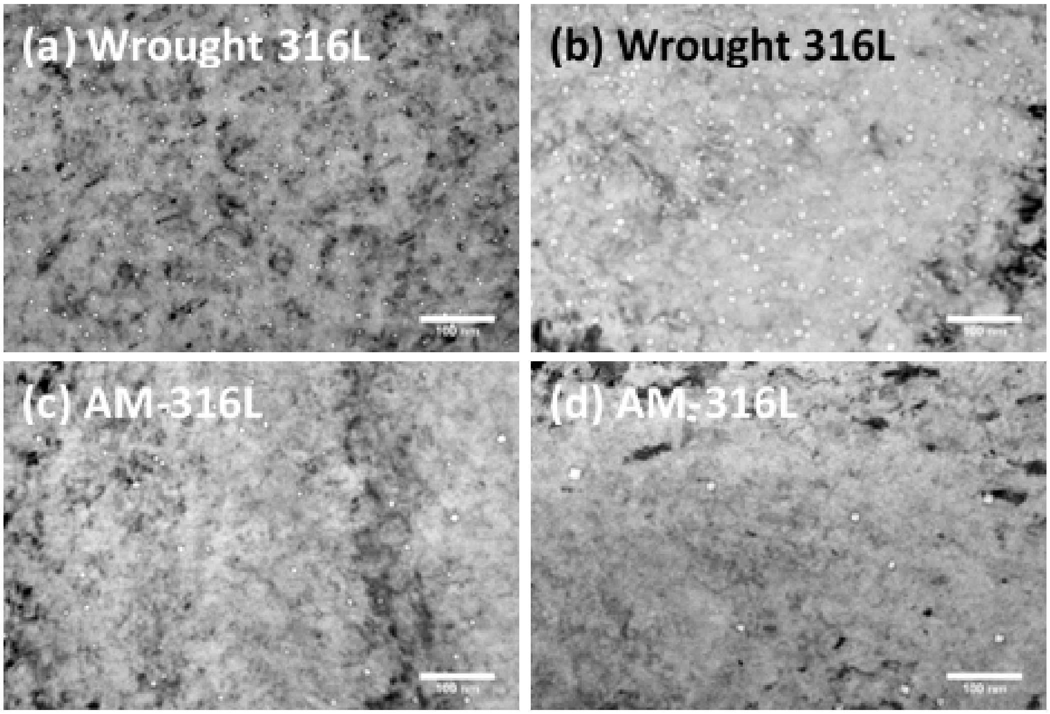
2. Alec Sample Mangan (UW): *High-throughput process mapping for additively manufactured 316L stainless steel and FeCoNiCrMn high entropy alloys.*



I am researching whether listening to the sound of the selective laser melting additive manufacturing process can identify defects while a part is being produced. One of the challenges with additive manufacturing is identifying and controlling defects during production. If we can identify these defects early enough in the build process, we can fix them or stop the process which saves valuable time and resources. Ultimately, my research will unlock a new technique for studying selective laser melting additive manufacturing.

3. Miguel Pena (TAMU): *Correlation of irradiation responses and microstructures in AM 316 stainless steels.*

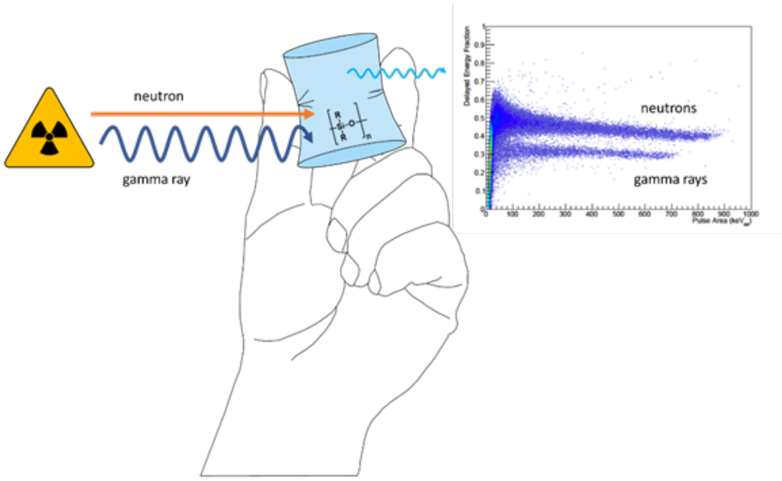
Additive manufacturing (AM) creates various unique micro-structures, which can lead to unique behaviors under neutron and ion irradiation. The project aims to identify the correlations between irradiation responses and characteristic features of AM alloys. Hence we can establish the relationship between irradiation tolerance and processing parameters. Neutron irradiations can take a significantly long time to complete, so in order to get meaningful data in a timely manner irradiations have been performed with both light and heavy ions. The irradiation responses that are being investigated include void swelling, precipitation, and boundary segregation. Knowledge on the aforementioned responses is necessary for the application of additive manufactured alloys in reactor environments and to further optimization of the AM process. At the later stage of the project, we will proceed to ion beam analysis of AM alloys, as a way to characterize alloys' composition and porosity.



ETI RESEARCH SPOTLIGHTS

Thrust Area 3

1. Allison Lim (CSM): *Development of PSD capable plastic scintillators.*

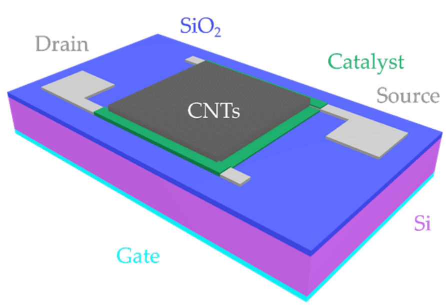


Plastic scintillators are an economical option for detection of special nuclear materials, such as uranium and plutonium. Traditional plastic scintillators are based on polymers like polystyrene and poly (vinyl toluene) doped with high concentrations of fluorescent small molecules. These formulations are stable under ambient conditions and can distinguish between neutrons and gamma rays, enhancing their ability to detect special nuclear materials. However, this class of plastic scintillator is afflicted by long processing times and applications are limited by the material properties of the polymers. Recent collaboration between Colorado School of Mines and Georgia Tech has expanded on potential application of plastic scintillators by exploring a new type of plastic scintillator based on elastomeric polysiloxanes. Polysiloxane scintillators have shorter processing times, just 3 hours compared to week-long processes for traditional scintillators, and are not sensitive to oxygen during fabrication. Polysiloxane scintillators also had radiation detection capabilities similar or better than the commercial scintillators, using only 1-5 wt% of commercial or synthesized dopants, contrasted to 20-30 wt% required in traditional plastic scintillators. This collaboration highlights the potential of polysiloxanes as a flexible matrix for detection of neutrons and gamma rays.

Publications:

Lim, A.; Arrue, J.; Rose, P. B.; Sellinger, A.; Erickson, A. S. Polysiloxane Scintillators for Efficient Neutron and Gamma-Ray Pulse Shape Discrimination. *ACS Appl. Polym. Mater*. 2020, acsapm.0c00641. https://doi.org/10.1021/acsapm.0c00641.

Lim, A.; Arrue, J.; Rose, P. B.; Sellinger, A.; Erickson, A. S. "Polysiloxane scintillators for neutron and gamma-ray pulse shape discrimination" *SPIE Optics and Photonics*, August 2020



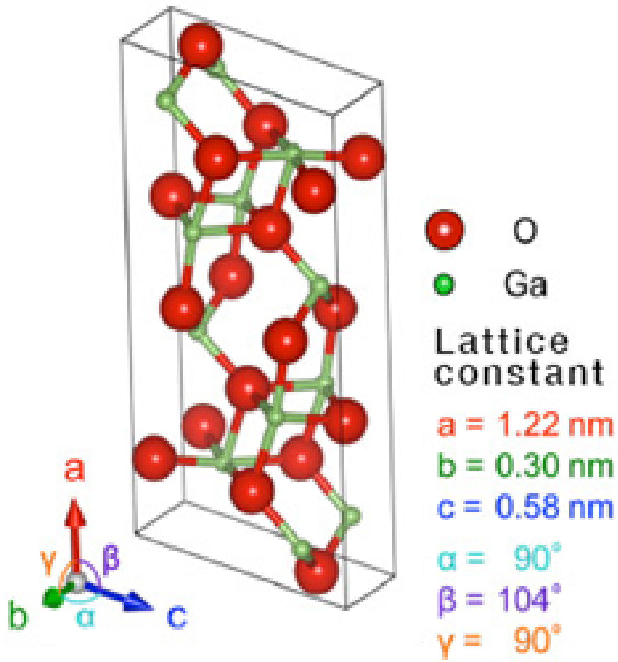
2. Arith Rajapakse (GT): *Carbon nanotubes as an ionizing radiation sensor.*

The goal of this project is to build a vertically aligned carbon nanotube (CNT) based detector that senses the charge generated by ionizing radiation in a traditional semiconductor detection volume. The electric field emanating the charge carriers generated in detection volume change the CNT device conductivity. Therefore, ionizing radiation is detected as a change in the device current. The present CNT-based detector prototype responds weakly to ionizing radiation such as x-rays. To improve the radiation response, experiments aimed at both improving the device geometry and tuning the quality of the CNTs are being performed.

Publications:

Arith Rajapakse, Anna Erickson,"Improving the Ionizing Radiation Response of Carbon Nanotube Field Effect Transistor Detectors", IEEE Nuclear Science Symposium and Medical Imaging Conference, Manchester, United Kingdom, November 2019.

Paul B. Rose Jr., Arith Rajapakse, Anna Erickson, "Ionizing Radiation Detection Using Vertically Aligned Carbon Nanotube Array Transistors", IEEE Nuclear Science Symposium and Medical Imaging Conference, Sydney, New South Wales, Australia, November 2018.



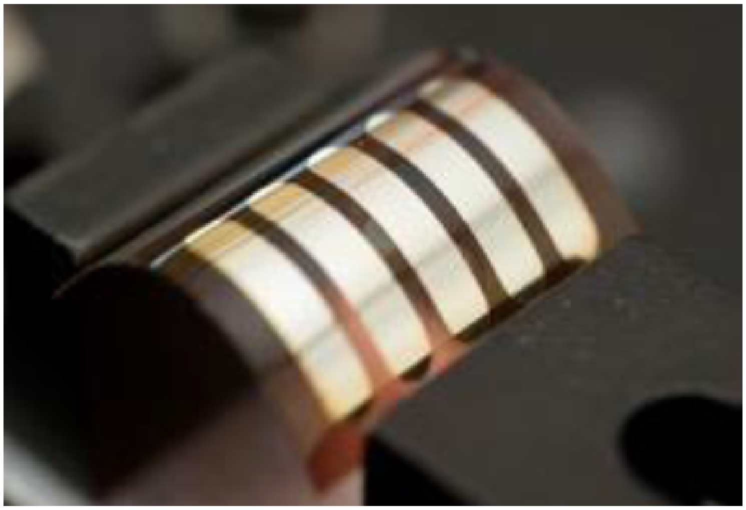
3. Joe McGlone (OSU): *Understanding proton radiation effects on the defect spectrum in high-mobility MOCVD-grown β-Ga2O3.*

Gallium oxide is a promising new electronic materials since it has the potential to enable a significant improvement in two critical technologies, high voltage power electronics for advanced power systems and high frequency transistors for future advanced communication systems. It also has the potential to withstand environments with high amounts of radiation. The work here is focusing on the relationship between synthesis of gallium oxide materials and the creation and properties of atomic-scale defects. One of the major areas of interest in this work is to idenitfy how these defects respond to damage from different types of radiation. With such knowledge, our goal is to understand the impact of such defects on the electronic and optical properties of gallium oxide so that future devices beyond the state-of-the-art today can be realized.

Presentations:

[1] Joe F. McGlone, Hemant Ghadi, Andrew Armstrong, George Burns, Zixuan Feng, A F M Anhar Uddin Bhuiyan, Hongping Zhao, Aaron R. Arehart, and Steven A. Ringel, "Proton Radiation Effects on Electronic Defect States in High-Mobility MOCVD-Grown (010) β-Ga2O3", Electronic Materials Conference, June 2020.

4. Oliver Moreno (GT): *Large area organic photodetectors for radiation detection applications.*



There is a need for reduction in size, weight, power consumption, and cost of radiation detectors to enable new ways of deploying sensors for nonproliferation. These factors are key to applications such as sensors mounted on swarm robotics, large area portals at transportation checkpoints, and UAVs. Legacy technology consists of PMT and scintillator rods. The organic photodetector (OPD) offers a compelling replacement solution because of the low-cost, simple fabrication methods, freedom afforded through material selection and design, and device stability. While we have demonstrated responsivities of 0.25 A/W comparable to those of Si photodetectors, response times of 30 microseconds remain a limiting factor for photon counting and detection of low-light levels necessary for radiation source detection and identification. The objective of our research is to further reduce response times by selecting new materials and exploring new device architectures and geometries. Our current approach is to leverage our understanding of surface treatments, data-driven modeling to reduce noise in OPDs, and to investigate the incorporation of small-molecule absorbers and bi-layer absorbers to further improve response times.

Presentations:

"Low-noise large-area organic photodiodes," C. Fuentes-Hernandez, W.-F. Chou, V. A. Rodriguez-Toro, Y. Park, Y.-C. Chang, F. A. Larrain, and B. Kippelen, presented at SPIE Optics and Photonics, Aug. 23-27, Virtual meeting (2020).

5. Neil Taylor (OSU): *Microelectronic devices: inkjet writing metal contacts on SiC for making alpha detectors.*

Additive manufacturing (AM) has created the possibility of replacing traditional manufacturing techniques with faster, versatile, and cost effective production options. We use aerosol inkjet printing, in collaboration with Dr. Pooran Joshi at Oak Ridge National Laboratory, to deposit metal contacts onto semiconductor wafers to produce radiation sensors. Aerosol inkjet printing deposits metal nanoparticles suspended in an ink solution using a gas stream and nozzle to selectively deposit the metal. These contacts create Schottky diodes that can act as both temperature and radiation sensors. We have successfully fabricated gold, silver and platinum devices capable of detecting alpha radiation with a best resolution of 1.8% FWHM at 5.486 MeV. These devices also operate as temperatures sensors up to 400° C. To understand how an annealing-free, in-air, metal laying process works for a Schottky barrier formation for a radiation sensor, we have also investigated the metal-semiconductor interface of these contacts using scanning electron microscopy (SEM), transmission electron microscopy (TEM) and atomic force microscopy (AFM). More interestingly is that a neutron conversion layer can also be printed below or on the top of a planar electrode or a pixelated electrode, thus fast track prototyping a neutron detector as a total counter or position sensitive detector. We hope that by better understanding this interface and printing process we can fabricate cheaper, faster and better detectors that complementary to the traditional cleanroom fabricated devices.

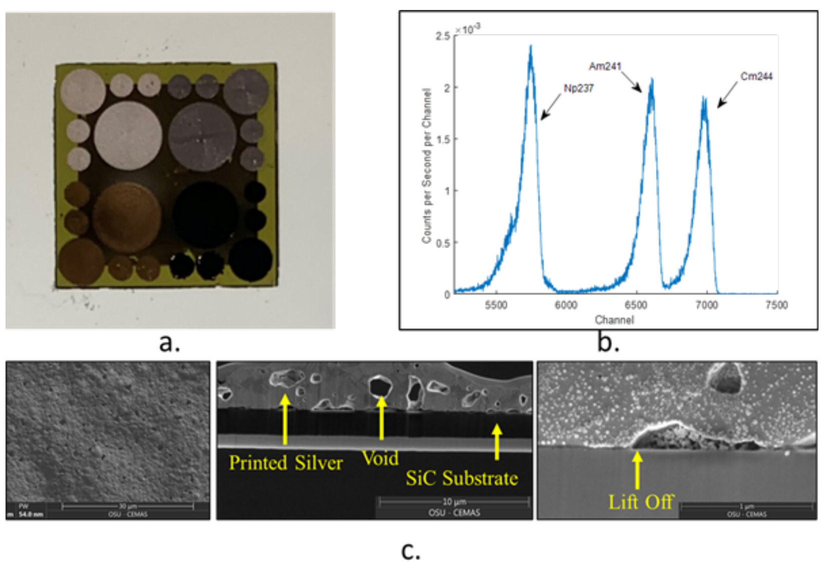


Figure 1. a. Printed metal contacts on 4H-SiC wafer with silver in top left, platinum in top right, and gold in bottom left, b. Pulse height spectrum of a triple-radionuclide source (Np237, Am241, and Cm244) from SiC with printed gold contact at -200V, and c. SEM and TEM images of printed silver metal-semiconductor interface.

Presentations:

Taylor, N., Alnajjar, N., Jarrell, J., Kandlakunta, P., Simpson, M., Blue, T., Cao, R.. "Isotopic concentration of uranium from alpha spectrum of electrodeposited source on 4H-SiC detector at 500° C." Journal of Radioanalytical and Nuclear Chemistry 320.2 (2019): 441-449.

Taylor, N. R., Kuang, W., Saeidijavash, M., Kandlakunta, P., Zhang, Y., & Cao, L. R. "Direct printing of metal contacts on 4H-SiC for radiation detection." AIP Advances, 9(9), (2019). 095041.

Kandlakunta, P., Tan, C., Smith, N., Xue, S., Taylor, N. R., Downing, G., Hlinka, V., Cao, R. "Silicon Carbide Detectors for High Flux Neutron Monitoring at Near-core Locations" Nuclear Instruments and Methods in Physics Research. (Accepted Nov. 2019)

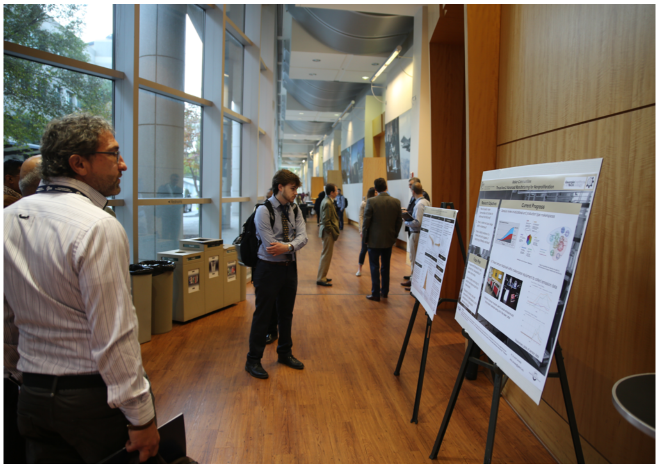
Ji, M., Taylor, N., Kravchenko, I., Joshi, P., Aytug, T., Cao, L., & Paranthaman, P. (2020). Demonstration of Large-size Vertical Ga_2O_3 Schottky Barrier Diodes. *IEEE Transactions on Power Electronics*.

Taylor, N. R., Yu, Y., Ji, M., Aytug, T., Mahurin, S., Mayes, R., ... & Joshi, P. C. (2020). Thermal and radiation response of 4H–SiC Schottky diodes with direct-write electrical contacts. *Applied Physics Letters, 116*(25), 252108.

ETI ANNUAL WORKSHOP (2019)

November 5–6, 2019

Georgia Institute of Technology (Georgia Tech) hosted the ETI Annual Workshop on November 5–6, 2019. Over 80 consortium partners and students attended. In addition to presentations from faculty co-principal investigators and representatives from national laboratories, students presented 16 posters and gave seven oral presentations. Students met with representatives from national laboratories to discuss research opportunities, and Georgia Tech personnel provided four lab tours.



ETI VIRTUAL SUMMER MEETING FOR YOUNG RESEARCHERS

July 7–8, 2020

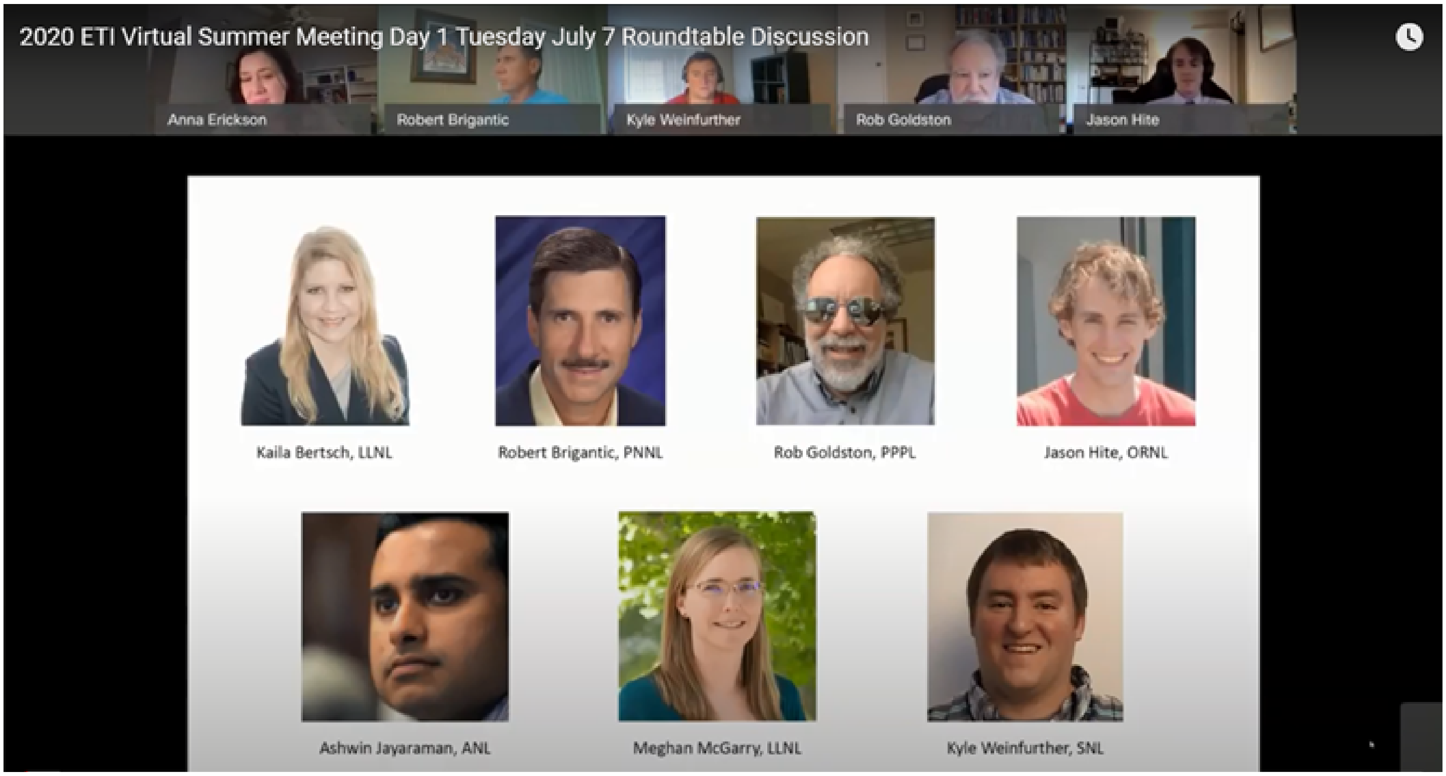
The ETI Consortium hosted a Virtual Summer Meeting on July 7-8, 2020, to offer students and young researchers an opportunity to showcase their research and to build new collaborations. Specifically, young researchers from national laboratories were invited to showcase their work and to participate in panel discussions with ETI students, researchers, and faculty. All presentations were virtual. The meeting was hosted by Lawrence Livermore National Laboratory (LLNL) via the Webex platform.

The virtual meeting included technical sessions, panels, and informal roundtable discussions about life and work at national laboratories. The presenters included ETI students, postdocs, and young researchers (postdocs and staff) at national laboratories. The roundtable discussion sessions invited early career researchers as panelists from the partnering national laboratories to provide their prospective on the work–life details at the national labs and to target recruitment of students for internships and postdoc for future transition to the labs. The presented topics covered all three thrust areas:

- Thrust Area 1: Computer & Engineering Sciences for Nonproliferation.
- Thrust Area 2: Advanced Manufacturing for Nonproliferation.
- Thrust Area 3: Novel Instrumentation for Nuclear Fuel Cycle Monitoring.

Students said their favorite parts of the meeting included the following:

- Seeing how all the research projects interacted and being introduced to new ideas and collaborators.
- This as a great opportunity to find collaborations!
- Hearing the breadth of work being done directly from students.
- It was cool to see all of the different areas of research that were occurring.
- Having most of the presentations come from students was a good choice.
- The roundtable discussions.



Roundtable Discussion at ETI Virtual Summer Meeting

ETI Achievements *by the Numbers*

3
Students Receiving B.Sc. Equivalent Degree

2
Students Receiving M.Sc. Equivalent Degree

2
Students Accepting a Job in the Field

8
Internships

2
Postdocs Transitioning to National Labs

9
Peer-Reviewed Publications Accepted

2
Book Chapters Accepted

1
Other Publication Accepted

8
Oral Presentations by Students

1
Oral Presentation by Postdocs

20
Oral Presentations by Professors/Faculty

20
Poster Presentations by Students

1
Poster Presentation by Postdocs

5
Poster Presentations by Faculty

8
Conference Papers/Reports

5
Keynote Speaker/Invited Talks

3
Outreach Programs

4
Courses Designed by ETI

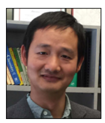
FACULTY AWARDS

Recognition for ETI Faculty Members

Aurora E. Clark was named a 2019 Fellow of the American Association for the Advancement of Science (AAAS). “The rank of fellow is the AAAS’s highest honor, awarded to members for their distinguished efforts to advance science and its applications for society.”

Anna Erickson was elected to the American Nuclear Society Board of Directors. Her term will run 2020–2023. She also received the American Nuclear Society’s 2019 Mary Jane Oestmann Professional Women’s Achievement Award.

Alfred Hero was elected Fellow of the Society of Industrial and Applied Mathematics (SIAM) for his “contributions to the mathematical foundations of signal processing and data science.” He also received IEEE’s Fourier Award “for contributions to the foundations of statistical signal processing with applications to distributed sensing and performance benchmarking.”



Jinsong Huang was promoted to Louis D. Rubin, Jr. Distinguished Professor, an endowed professorship in the College of Arts and Sciences at UNC Chapel Hill that recognizes outstanding scholarship and teaching and comes with an annual $10,000 research fund.

Bernard Kippelen received the “Thanks for Being a Great Teacher” Award from the Center for Teaching and Learning, Georgia Institute of Technology.

Steven A. Ringel was named a 2020 Institute of Electrical and Electronics Engineers (IEEE) Fellow for his “contributions to the advancements in compound semiconductor photovoltaics.”

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