

Consortium for Enabling Technologies and Innovation

Anna Erickson

Georgia Institute of Technology

April 27-28, 2021



Year 1 in pictures



Annual Summer School

Part I (Virtual) Theme: Data Science

August 24 – August 28, 2020

Summer school meeting will be

Register by July 15, 2020, at
<https://forms.gle/pjTC4NGgnnrKdoLc6>

Data science methods will be introduced, including hands-on tutorials on nonproliferation applications.

Join us! Here's what you'll get:

1. Connection between applications and data science
2. Education on the key topics
3. Introduction of resources
4. Immersive collaborative environment

Topic Areas (Modules):

- Day 1 – Fundamentals of Data Applications
Steve Biegalski (Georgia Tech)
- Day 2 – Computational Machine Learning
Alfred Hero (University of Michigan)
- Day 3 – Bayesian Modeling and Inference
John Fisher (MIT)
- Day 4 – Data Science for Safeguards
Karl Pazdernik (PNNL)
- Day 5 – Applications
 - Overview of UAV Technology, *Jonathan Rogers (Georgia Tech)*
 - Critical Aspects of Applying Machine Learning to Nuclear Threat Detection Problems, *Simon Labov (LLNL)*
 - Proliferation Detection Relevant Data Streams and Types, *Will Ray (ORNL)*

Monday July 7 Roundtable Discussion

Robert Brigantic

Kyle Weinfurter

Rob Goldston

Jason Hite



Kaila Bertsch, LLNL



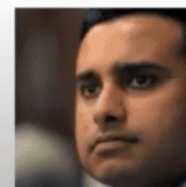
Robert Brigantic, PNNL



Rob Goldston, PPPL



Jason Hite, ORNL



Ashwin Jayaraman, ANL

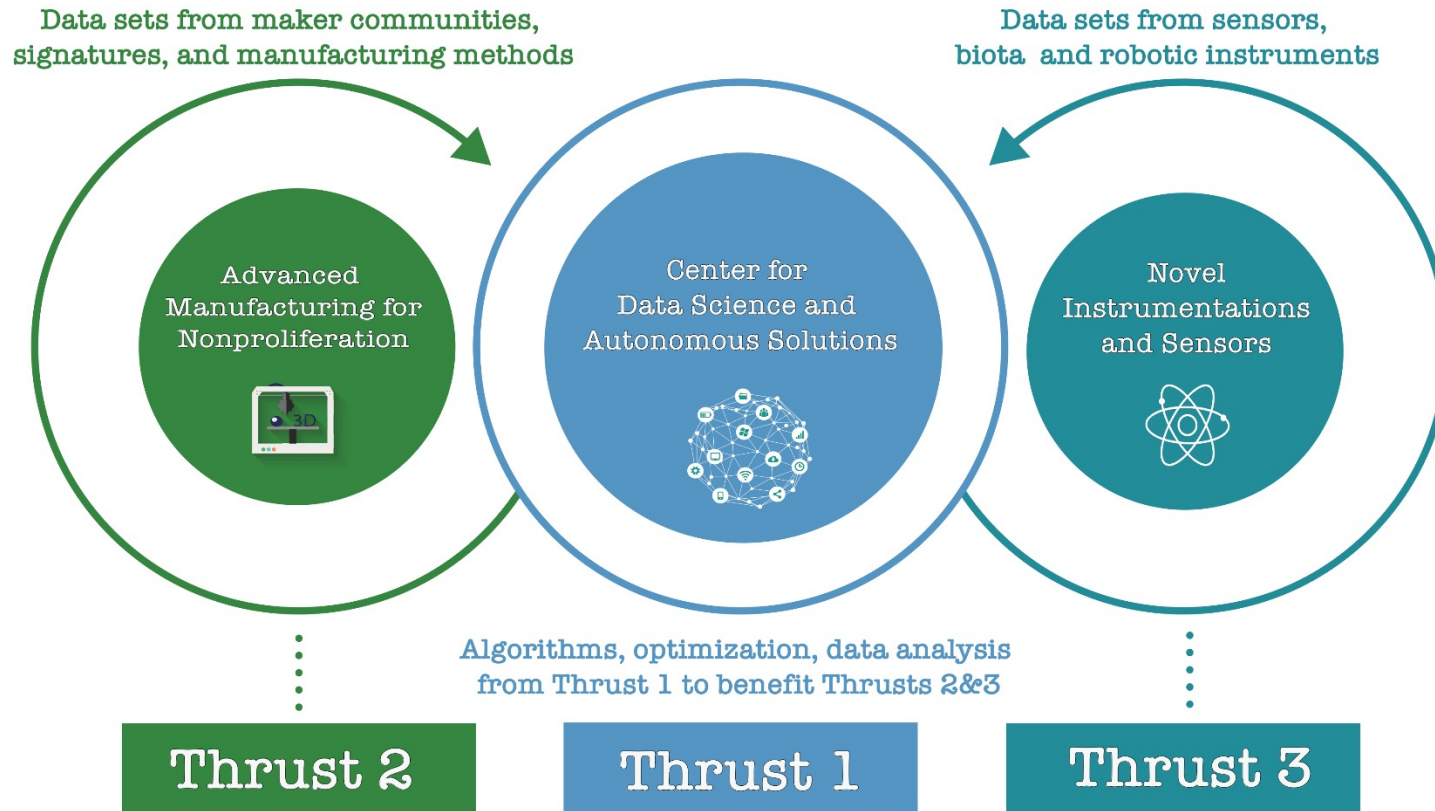


Meghan McGarry, LLNL



Kyle Weinfurter, SNL

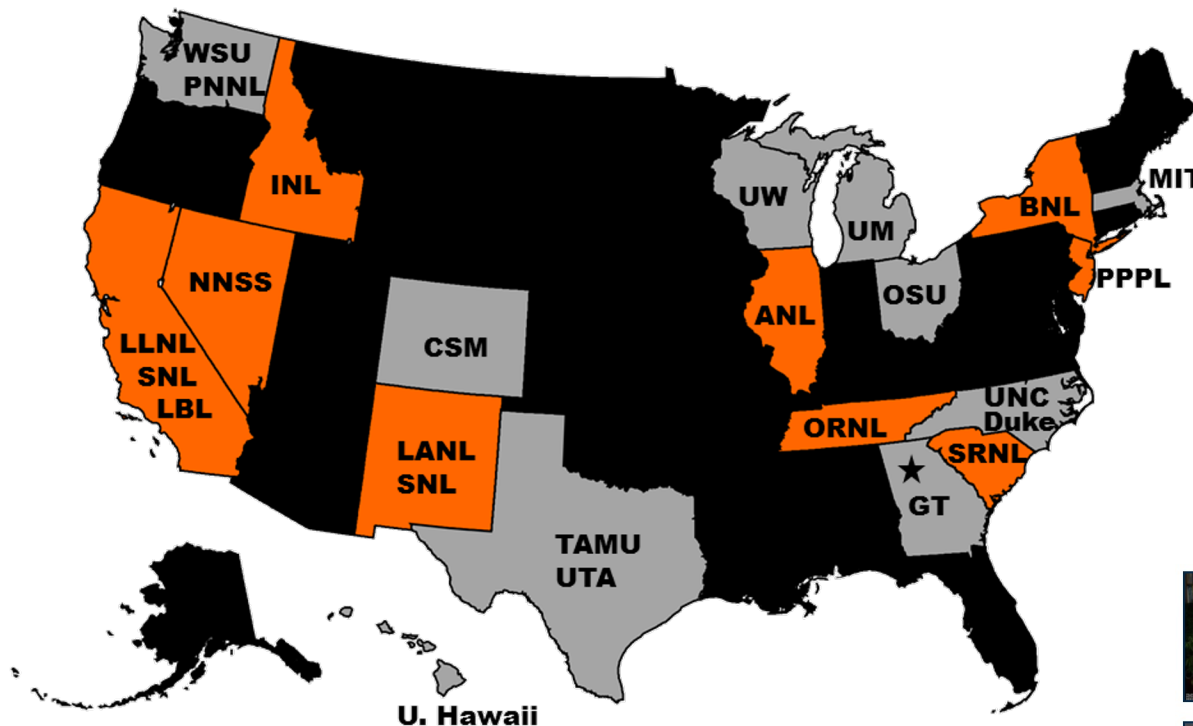
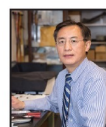
» ETI Structure and objectives



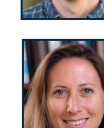
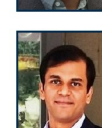
- ▶ To direct the research and innovation to enable the technologies that support the NNSA's mission and to bridge the gap between the university basic research and national laboratories mission-specific applications.
- ▶ To create a research and education environment to support cross-cutting technologies across three core disciplines.
- ▶ To support education, development, and transition to national laboratories or NNSA of students and postdocs.



ETI Team



UNIVERSITY PARTNER
NATIONAL LABORATORY PARTNER

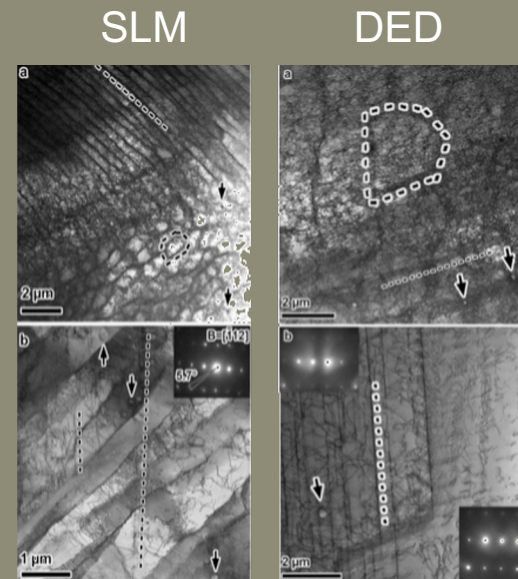


ETI Mission: To direct the research and innovation to enable the technologies that support the NNSA's mission and to bridge the gap between the university basic research and national laboratories mission-specific applications.



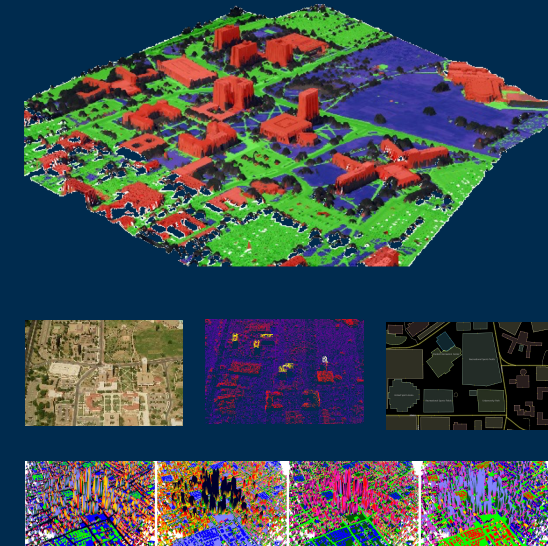
Thrust Area 2: Additive Manufacturing (AM) for Nonproliferation.

Material scientists, nuclear engineers and specialists in maker communities with a goal to address the most pressing needs in enabling technologies to determine unique signatures resulting from use of advanced manufacturing. Results will be a foundation for policy formulation to address these concerns.



D. Thoma (UW)

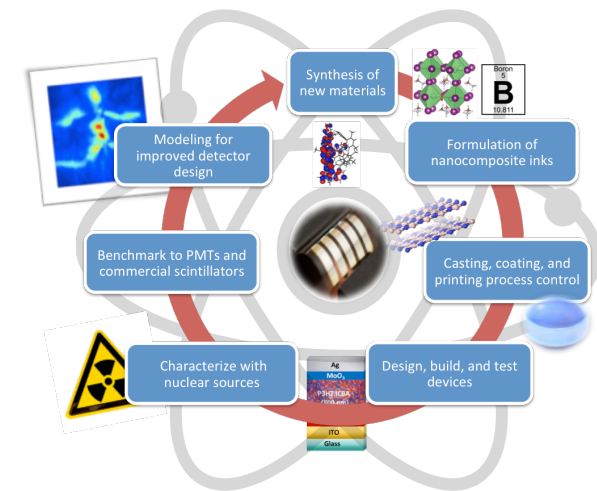
Thrust Area 1: Computer and Engineering Sciences for Nonproliferation (CESN).
A multidisciplinary team composed of computer and data scientists, nuclear and aerospace engineers, chemists and biologists to take advantage of new-age computational and hardware capabilities in data science and remote detection.



J. Fisher (MIT)

Thrust Area 3: Novel Instrumentation (NI) for Nuclear Fuel Cycle Monitoring.

The aim is to integrate into MTV Consortium solutions and national laboratories' research using expertise from nuclear engineering, material scientists, chemists and electrical and computer engineers.



B. Kippelen (GT)



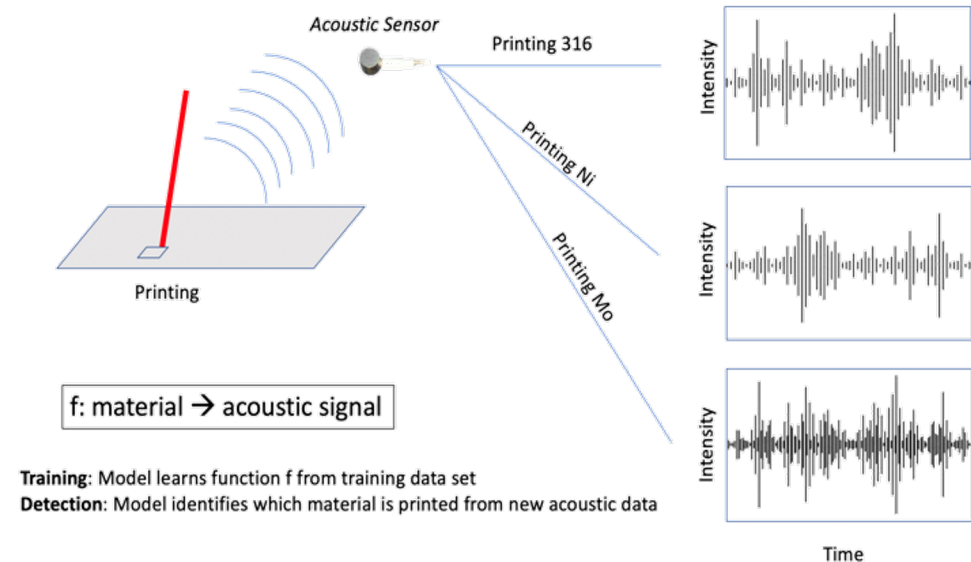
Machine Learning and Data Challenges

Example 1: Behavior Inference from Integrated Fuel Cycle System Models:

- Identify material diversion pathways in complete nuclear fuel cycles
- Simulate signatures of material composition and flow
- Various machine learning techniques applied to simulated signals to infer behavior of facility agents
- Collaboration with MTV on facility modeling/signatures

Example 2: Machine Learning and Big Data Challenges in Advanced Manufacturing:

- Advanced manufacturing systems are heavily instrumented to provide quality control data.
- Side channel data including acoustic measurements provide information on the manufacturing process.
- The combination of these data may provide unique signatures on the activities conducted and items being manufactured.
- Machine learning algorithms will be utilized by ETI to identify the importance of each data channel and to identify unique signatures.

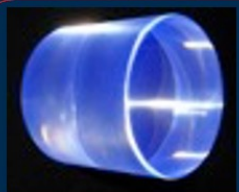




Nuclear Fuel Cycle Monitoring: Light Collection

Conversion

Light collection and detection

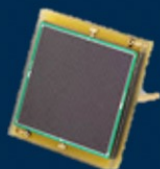


Scintillators



PMTs

\$ 1000 – 10,000
1 – 4 cm²



Si-PMs

\$ 100 – 1000
0.1 – 10 cm²



Si avalanche photodiode
(Si APD)

Si-photodiode
(Si PD)

LEGACY
TECHNOLOGY

I_{ph} (photons cm⁻² s⁻¹)

10²

10⁴

10⁶

10⁸

10¹⁰

10¹²

10¹⁴

10¹⁶

10¹⁸

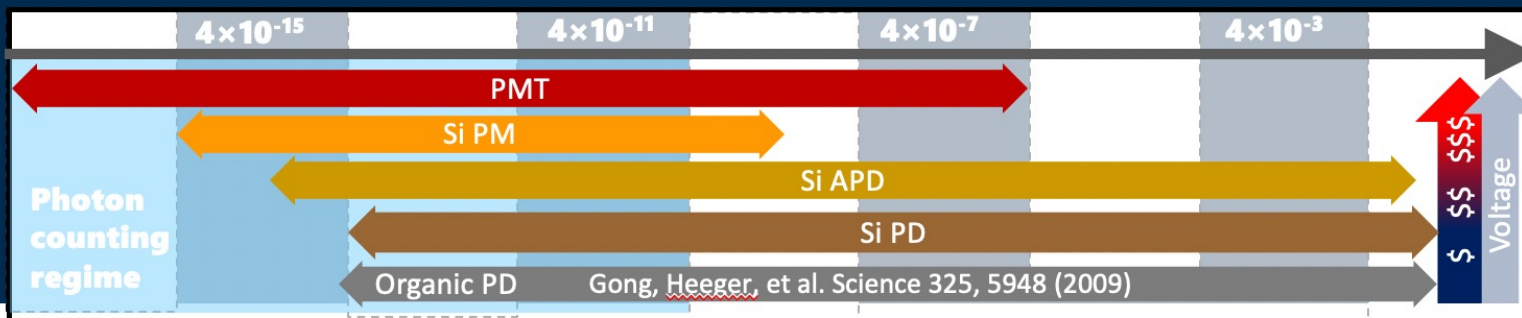
$I_{550\text{ nm}}$ (W cm⁻²)

4×10^{-15}

4×10^{-11}

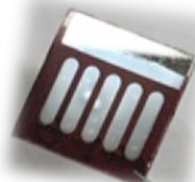
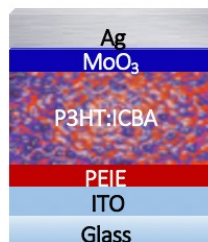
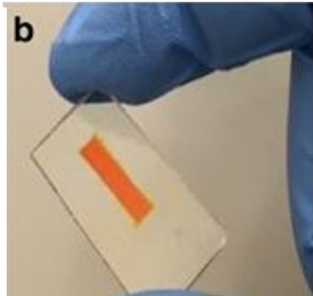
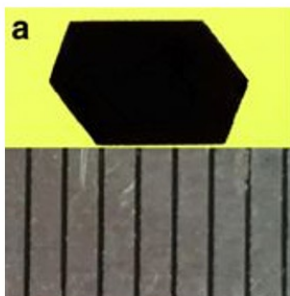
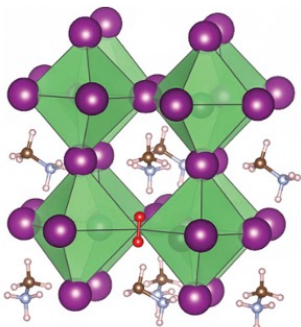
4×10^{-7}

4×10^{-3}

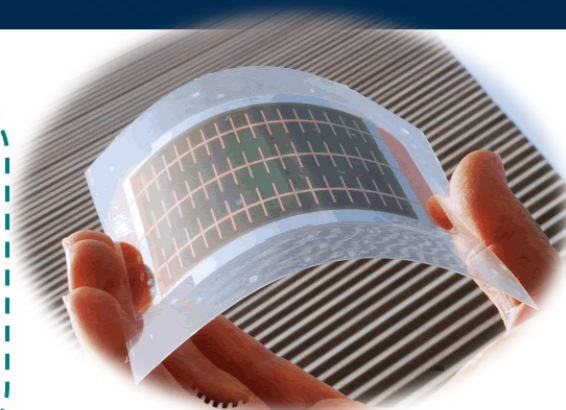


NEXT
GENERATION:

Hybrid perovskite for weak light sensing



Organic/hybrid
photodiodes and
scintillators
< \$ 0.5 per cm²

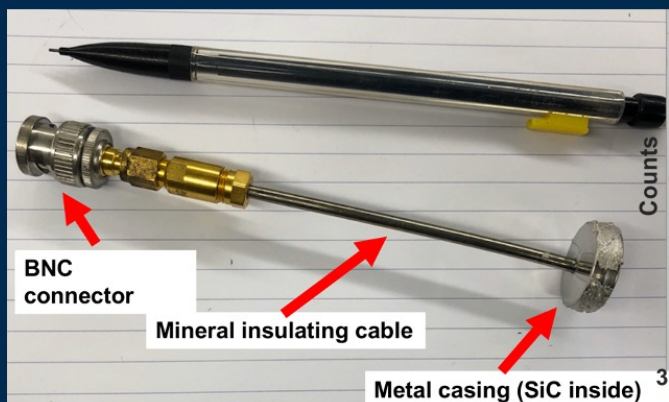


Adapted from Hamamatsu



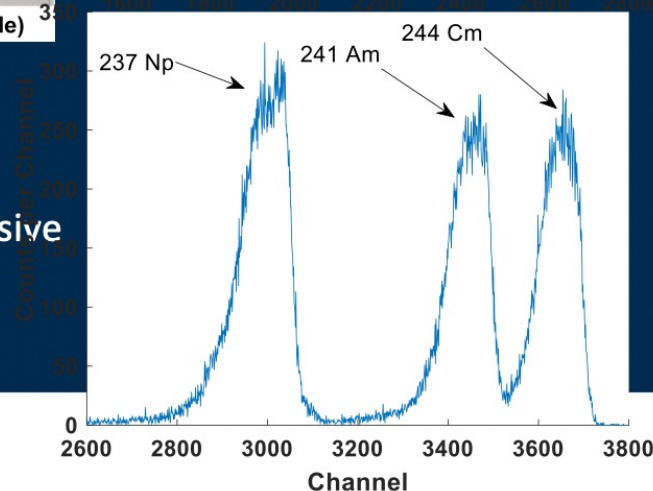
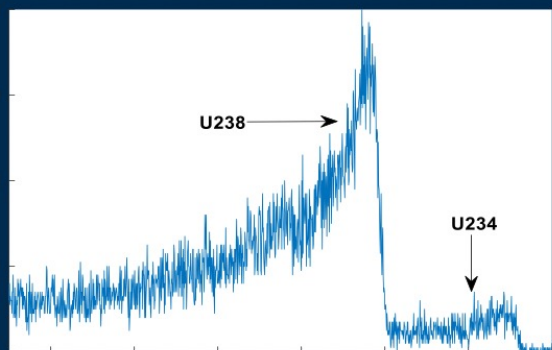
Nuclear Fuel Cycle Monitoring: Material and Sensor Development

Development of SiC for actinides monitoring during flowsheet of pyroprocessing



A packaged SiC device

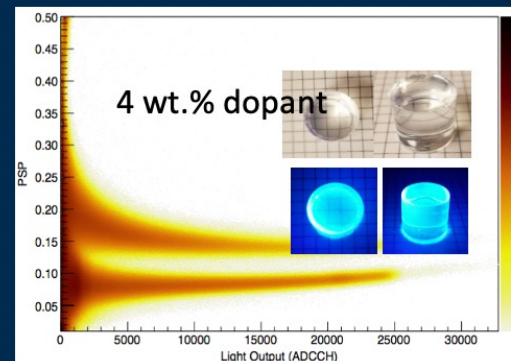
SiC alpha detector is fabricated and packaged, which survives 500 C corrosive molten salt environment for pyroprocessing SNM monitoring



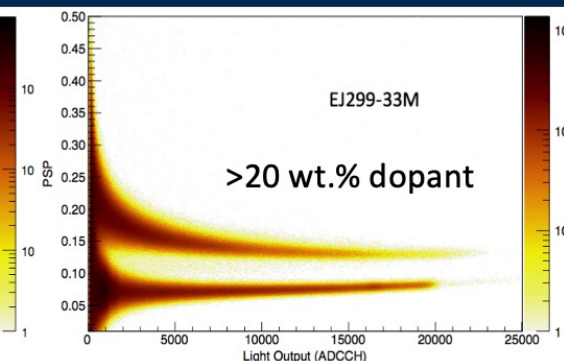
3.32% FWHM at 5.486 MeV

New material development

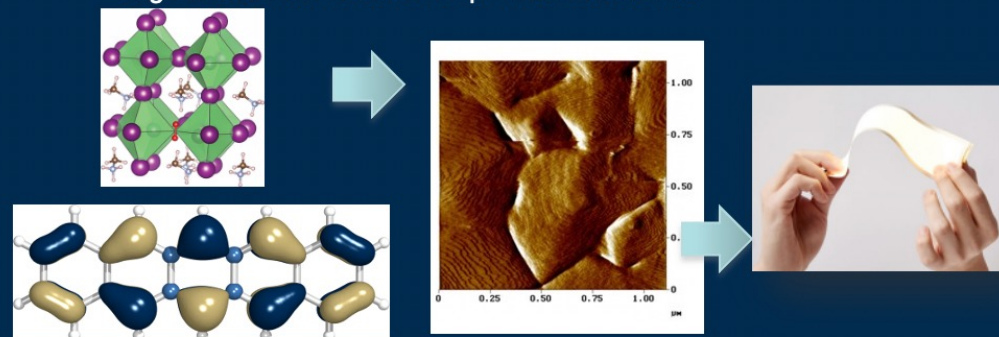
Initial performance of our material



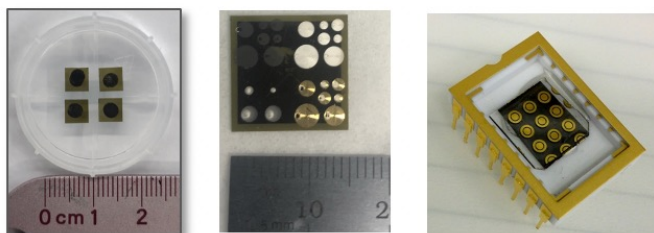
Commercially available PVT based product



Organic semiconductors for printed electronics



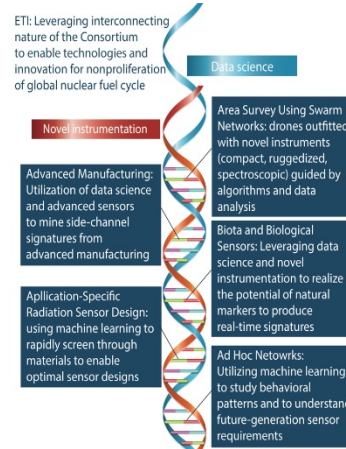
Processing at room temperature onto any substrate: foil, plastic films, paper, elastomers



Technical Education, Outreach and Workforce Development

Goals of the educational program

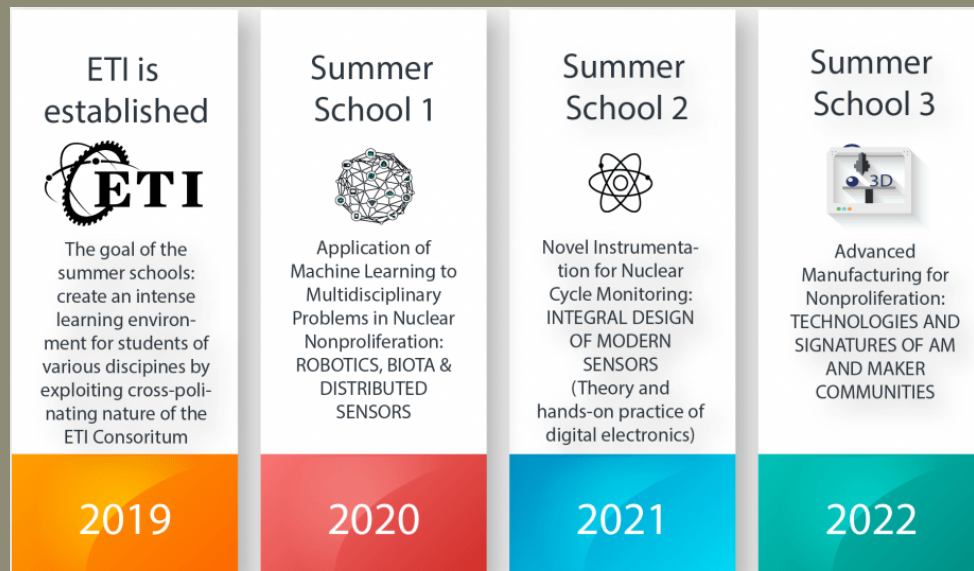
- Provide NNSA with a continuous supply of highly trained scientists
- Provide opportunities for the ETI students to do research at national laboratories.
- Assemble strong university-lab research and education bridges
- Build the next generation of leaders



Laboratory and Site/Complex Internship and Rotations

- Laboratory and Site/Complex Rotations: in addition to student-targeted internship funding, ETI will support student-faculty and student-postdoc pairs to participate in 4-8 week laboratory rotations.
- Laboratory Dissertation Committee Members: each graduate student will include a thesis committee member from a national laboratory

Interdisciplinary Curriculum Development, Summer School



Engagement of students from MSI

- Provide students with an opportunity to intern at a PhD-granting institution
- Provide opportunities for the students to develop relationships with the future grad school advisor
- Provide educational and networking opportunities
- Fellowships and scholarships
- Current partners: Claflin University, Spelman University



Major Events

Kick-off Meeting

- April 30 – May 2, 2019
- Nearly 100 participants representing consortium partners, national laboratories and government.



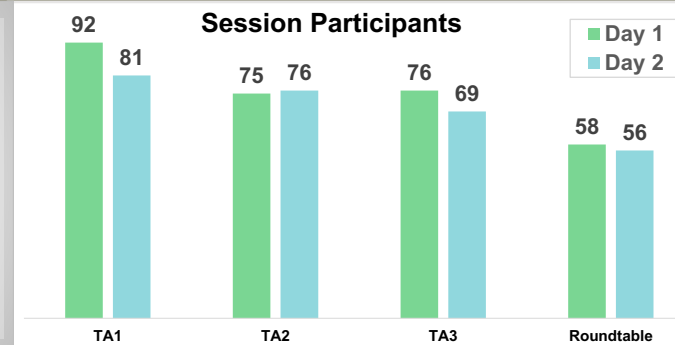
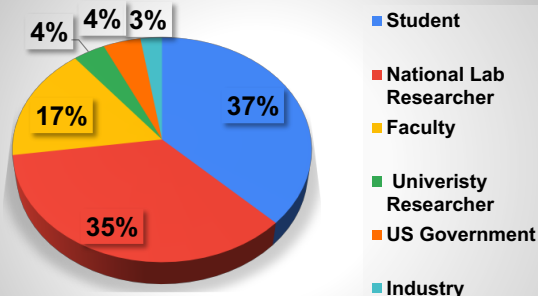
2019 ETI Annual Workshop

- November 5 – 6
- 26 oral presentations
- 16 poster presentations
- Research group discussion
- Academic program discussion
- National Laboratory internship
- Technology transfer meeting
- Lab tour



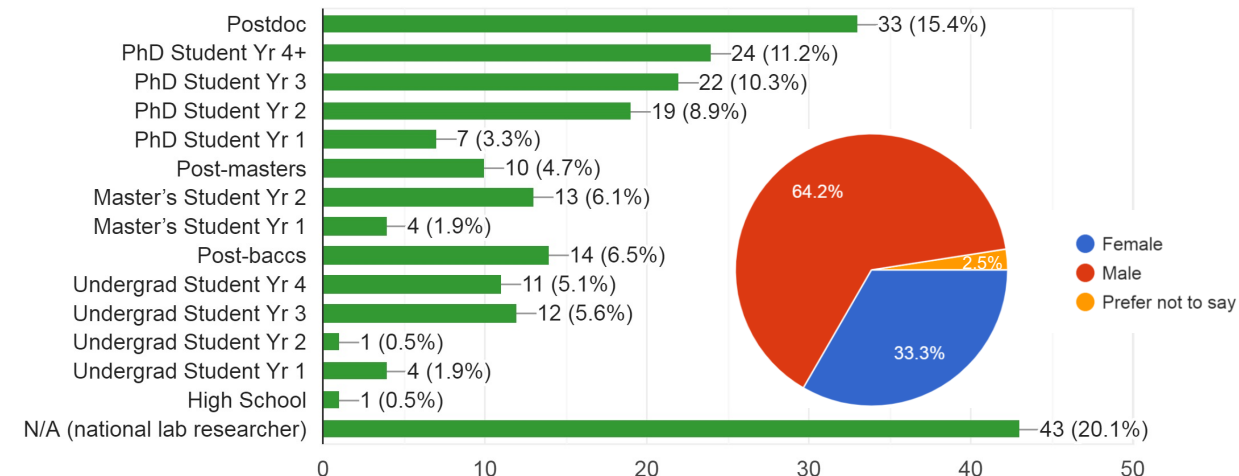
2020 ETI Virtual Summer Meeting for Young Researchers

- July 7-8, 11am - 4pm (ET)
- Co-host with LLNL via WebEx
- 28 oral presentations
- 2 roundtable sessions
- Exchange of research and innovation between NLs and IHEs
- Integration of cross-cutting projects
- NNSA feedback, social interactions



2020 ETI Annual Summer School -- Data Science and Engineering

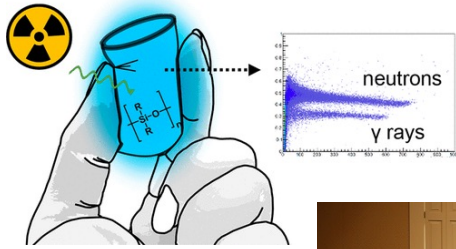
- August 24-28, 11am-5pm (ET), WebEx
- Over 210 registrations



Major Achievements

Products

- 4 book chapters
- 46 peer-reviewed journal articles
- 42 courses developed
- 19 conference papers
- 127 other presentations (invited talks, posters, seminars)



Educational Resources

- Summer School resources are available on ETI website
- Summer meeting presentations are also available
- ETI101 - under development to be offered in Fall 2021

ETI VIRTUAL SUMMER MEETING FOR YOUNG RESEARCHERS

July 7–8, 2020

ETI SUMMER SCHOOL 2020

Two-Part Workshop on Data Science and Engineering

Module 1: Nuclear science of radiation interactions and applications (8 lectures)

Module 4: Overview of nuclear security and nonproliferation (10 lectures)

Module 2: Nuclear engineering of reactors and systems (8 lectures)

ETI 101

Module 3: Nuclear fuel cycle and waste management (8 lectures)



ETI 101 Course: Fundamentals of Nuclear Science and Engineering for Nonproliferation

- Semester-long introductory course: January 12 – May 6, 2021
- 4 Modules (34 lectures)
- 19 speakers/lecturers from 13 institutions (6 national labs)
- Over 370 participants, 440 video views





The Consortium for Enabling Technologies & Innovation (ETI)

Annual Summer School

Novel Instrumentation and Sensors for Nuclear Fuel Cycle Monitoring

July 12 – July 15, 2021 (Virtual)

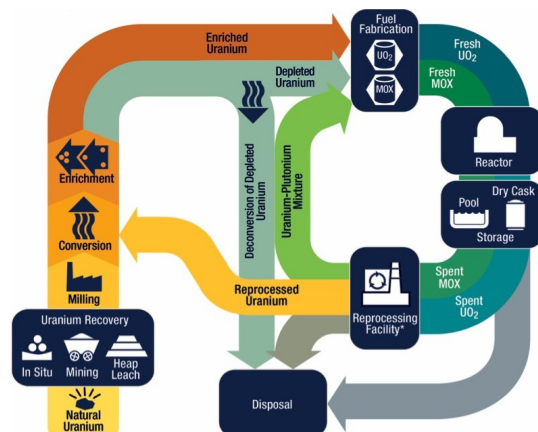
Summer school meeting will begin at 11 a.m. ET

Register by June 30, 2021:

<https://forms.gle/bKMevFvHqJVwDfoX9>

Join us! Here's what you'll get:

1. Application of radiation detection to fuel cycle monitoring
2. Exploration of new technologies
3. State-of-the-art demonstrations
4. Immersive collaborative environment



Radiation detection and nuclear fuel cycle monitoring will be explored. Lab demonstrations and virtual tours will be conducted.

Topic Areas (Modules):

- Day 1 – Basic Radiation Detection Topics

Steven Biegalski, Anna Erickson (Georgia Tech)

- Day 2 – Basic Radiation Detection Topics/Safeguard Measurement

Angela Lousteau (ORNL)

- Day 3 – Safeguard Measurement/Plastic Scintillators/GaN Devices

Vladimir Mozin, Vincenzo Lordi (LLNL)

Alan Sellinger (Colorado School of Mines)

Siddharth Rajan (Ohio State)

- Day 4 – Biota/Advanced Materials/Photosensors

Martine Duff (SRNL)

Jinsong Huang (University of North Carolina)

Bernard Kippelen (Georgia Tech)



<https://eti.gatech.edu>

»» Thank you!

This work has been supported through the Consortium for Enabling Technologies and Innovation by the Department of Energy/National Nuclear Security Administration under Award DE-NA0003921.

