

ISU-CAES Quarterly Report
FY21 Q2: January, February, March 2021

(1) Journal Publications and Patents

Anil K. Prinja, Minghui Chen¹, Nicholas R. Brown, **Amir F. Ali**, Wade Marcum, Youho Lee. Kurt A. Terrani. Paul Rebak, and Edward Blandford, 2020. "An Experimental and Analytical Investigation into Critical Heat Flux (CHF) Implications for Accident Tolerant Fuel (ATF) Concepts," DOE- NEUP Award 17-12688 Final Project Report

P. Mena, K. Wilsdon, K. Massey, D. Nielson, K. Casanova, C. Hill, P. Gilbreath, and **L. Kerby**, Government Expenditure Data Exploration & Analysis Using Python, Athens Journal of Sciences, in press. <https://www.athensjournals.gr/sciences/2019-3829-AJS-ENG-Mena-05.pdf>

C. Juneau, A. Johnson, K. Wilsdon, and **L. Kerby**, An Introduction to a Generalized FunctionalExpansion Tally Library, Transactions of the American Nuclear Society **123** (2020).

P. Mena, R. Borrelli, and **L. Kerby**, Nuclear Reactor Transient Diagnostics using Classification and AutoML, Nuclear Technology, in press.

S. Chowdhury, B. Liaw, Y. Lin, and **L. Kerby**, Evaluation of Tree Based Regression over Multiple Linear Regression for Non-normally Distributed Data in Battery Performance, in preparation.

Barrett Durtschi, Mahesh Mahat, **Mustafa Mashal**, and **Andrew Chrysler** (2021). "Preliminary Analysis of RFID Localization System for Moving Precast Concrete Units using Multiple-Tags and Weighted Euclid Distance k-NN algorithm", 15th Annual IEEE International Conference on RFID (IEEE RFID 2021), April 27-29 2021, Atlanta, GA, USA. (Paper has been submitted, pending review).

Shishir Khanal, Uma Shankar Medasetti, Rajiv Khadka, **Mustafa Mashal**, and **Bruce Savage** (2021). "Virtual and Augmented Reality in Disaster Management: A Literature Review of the Past 10 Years", 2021 IEEE International Symposium on Mixed and Augmented Reality (ISMAR), October 4-8, 2021, Bari, Italy. (accepted for presentation)

J. D. Bess, **C. L. Pope**, A. Chipman, C. B. Jensen, Utility of EBR-II Benchmark Model to Enable MOX Fuel Pin Characterization, *Transactions of the American Nuclear Society*, in press (2021).

Z. Ma, S. Zhang, **C. L. Pope**, C. Smith, Research to Develop Flood Barrier Testing Strategies for Nuclear Power Plants, US Nuclear Regulatory Commission, NUREG/CR-7279, in review, (2021).

S. H. Giegel, A. E. Craft, G. C. Papaioannou, A. T. Smolinski, **C. L. Pope**, Neutron Beam Characterization at Neutron Radiography (NRAD) Reactor East Beam Following Reactor Modifications, *Quantum Beam Science*, in print (2021).

A. Wells, E. D. Ryan, **C. L. Pope**, *Improving Nuclear Power Plant Flooding Hazard Analysis Through Component Performance Experiment, Fragility Model Development, and Smoothed Particle Hydrodynamic Simulation*, (2021), book chapter, in review.

R. Rodriguez: Manuscript Number: MOLLIQ-D-20-00713R1 Revision Accepted by the Journal of Molecular Liquids: Extraction of lanthanides and actinides present in spent nuclear fuel partitioning and in electronic waste, not published yet

Bruce Savage: Non-Provisional Patent Application and associated documents filed. *Submerged Oscillating Water Column Energy Harvester*. The Application Serial No. is 17/209,665 and the filing date is 03/23/2021

(2) Conference Presentations

Amir Ali, Piyush Sabharwall, In-Plan Oval-Twisted Spiral Tube Heat Exchanger for Nuclear Applications: American Nuclear Society Annual Meeting, Providence, RI, June 13-16, 2021.

Scott Wahlquist, **Amir Ali,** Heat transfer in randomly packed spheres for FHR reactors: American Nuclear Society Annual Meeting, Providence, RI, June 13-16, 2021.

B. Durtschi, **A.Chrysler,** 2021, Preliminary Analysis of RFID Localization System for Moving Precast Concrete: ISU Undergraduate Research Symposium, Pocatello ID 2021

J. Amir, B.Durtschi, **A.Chrysler, P. Bodily,** 2021, "Radio Frequency Identification Vibration Detection Using Long Short-Term Memory," in National Conference on Undergraduate Research.

Nicholas J. Wiles, Lexee C. Bair, Jason Jones, Camden L. Sudweeks, Kendal P. Olson, **Joshua J. Pak,** and **Courtney L. Jenkins,** 2021, Model Study of Urethane Degradation by Gamma Radiation for Polyurethane Upcycling: ISU Undergraduate Research Symposium, Pocatello ID

(3) CAES-related **partnerships and collaborations** this Quarter, including ongoing projects in CAES building

Amir Ali: Collaboration activities with the University of Wisconsin Madison for investigating surface wettability and CHF prediction for new Chrome coated Zirc alloys for Accident Tolerant Fuel (ATF) program. Wisconsin provided samples, and ISU/CAES conducts the measurements and prediction of CHF information at different temperatures. The expected outcome is in the form of a joint journal publication in 2021.

Cori Jenkins: We have continued to collaborate with Drs. Chris Zarzana and Brittany Hodges at INL to irradiate model compounds.

Leslie Kerby: co-lead CDV working group, Data science workshop this summer with Lan Li, collaboration with Som Dhulipala for several proposals

Dan LaBrier:

Project 1: Heat Treatment and Autoclave Testing for Novel Hydraulic Loop Coupling; BEA Subcontract 154652-62 (Nate Oldham, Tom Maddock, Nic Woolstenhulme, all INL)

Project 2: Integrated Sensor Development for Used Fuel Storage Canisters; BEA Subcontract 154652-79 (Evans Kitcher, Phil Winston, Michael Fanning, Nancy Johnson - all INL)

Project 3: Chemical Interactions between Molten Sodium & Standard Insulation Types; self-funded (using ISU CAES Seed Grant funding), collaborative project w/INL

Project 4: ATR-C & ATR Gamma Tube - Student Engagement (Dave Schoonen, Ryan Little, Monica Dudenhoeffer – all INL; Rich Christensen – UI; Brian Jaques – BSU)

Project 5: Use of UHP Concrete in Nuclear Applications (Mustafa Mashal, Arya Ebrahimpour – ISU; Kunal Mondal, Drew Johnson, Elmar Eidelpes – INL)

Solomon Leung: I have ordered equipment (Cary 100) upgrade and now dealing with the vendor scheduling. Literature search is on going and will be having a STEM student to be responsible for this item, for preparation of a reviewing paper. We just started experimentation, many troubling shootings as usual, no results yet to be reported.

Mustafa Mashal: Discussed the Disaster Response Complex and possible collaboration on certificate programs and training events with Liam D. Boire at INL.

Sean McBride: The Industrial Cybersecurity Education and Training Community of Practice co-founded by INL and ISU has developed five sub-groups: Workforce development, Career pathways, Standards, Hands-on, and Repository. Each group has created a mission statement. Members include academics from various universities and industry. Sean McBride leads the standards subgroup, which meets monthly

Kendra Murray: This quarter, my INL collaborator Dr. Xiaofei Pu worked hard to finalize how we will use CAES facilities to perform our proposed analytical work on a Scanning Electron Microscope (SEM). After determining that our initial plan, to use the SEM-WDS system at the MFC, was not going to work because we could not easily bill for time on this instrument, we reached out to Dr. Yaqiao Wu and others at the CAES/MaCS facility. The SEM-EDS at this facility is sufficient for our work with moderate adjustments to our work plan. As of early April 2021, Dr. Pu has subsequently received approval to access CAES from her management, completed the online training for the MaCS facility, and been trained to use the SEM-EDS.

Rene Rodriguez: Continued collaboration with Dr. Kavita Sharma, Dr. Mustafa Mashal, Dr. Kunal Mondal, and Dr. Bruce Savage on Hydrogen Storage, received CAES Seed grant to further the collaboration.

Keith Weber: a few meetings with the revived C3+3 group and discussion of pursuing an NSF CC* proposal. We meeting bi-weekly. This may be more C3 related but of course discussion of research at CAES has been part of the meetings also.

Irene Van Woerden: The project looking at perceptions of nuclear energy has received IRB approval, the qualtrics survey is fully ready, and the advertising blurb and image is also ready. As we have included the ISU name/logo on the advertising image we are waiting on approval of use - survey dissemination can occur fairly immediately after approval is obtained. The "methods" paper describing the project methods is nearly fully drafted, and my students are well on their way with understanding the literature to answer their own research questions.

Justin Wood: I have leveraged the insights and relationships I developed from my CAES involvement last summer into a new CASE-related collaboration. I have joined Ron Fisher (INL), Richa Sabharwall (INL), Lydia Greco (INL), Celia Porod (INL), and Marcus Burger (ISU) in a project creating research proposals wherein we explore the insights that the accounting, finance, and economics research literatures have for motivating the stewards of critical infrastructure to protect that infrastructure as part of the CAES Visiting Faculty Program for the summer of 2021.

(4) Proposals and Awards

See attachment at end

(5) Other - Any other impactful or pertinent information related to CAES?

David Beard: In collaboration with the INL cybersecurity group, I helped develop the new ISU undergraduate Computer Science Certificate and the new graduate Cyber Operations certificate that are now available in the 2021-2021 ISU catalog

ESTEC:

(1) Two ESTEC Faculty (Mackenzie Gorham and Ryan Pitcher) participated in an event entitled “*STEM Up*”, which was held for the Pocatello School District during their Spring Break. ESTEC Faculty worked with students in grades kindergarten, first, fourth and fifth. It is estimated that 3,600 students participated in the event overall. Co-Sponsored by INL

(2) ESTEC personnel are working on the planning phases of holding another *Ignite Their Future* summer camp during 2021.

(3) ESTEC programs have held their Spring Technical Advisory Committee meetings, with numerous local and regional industries being represented.

Cori Jenkins: 5 undergraduate students have gained hands on research skills including two students from populations underrepresented in STEM. Two students will be graduating with degrees in Chemistry and Biochemistry next month. Two additional students have been recruited for summer research.

Leslie Kerby: Have had students apply for and receive internships at the INL. Some of my students have also now matriculated into full-time employment at the INL (after an internship).

Mustafa Mashal: The DRC will be hosting about a dozen exercises in collaboration with INL this year.

Bruce Savage: Concept Paper Submitted to DOE ARPA-E OPEN 2021 titled: Increasing Pumped Storage Infrastructure Viability using Recycled Tires. ISU Collaborators: Bruce Savage, Mustafa Mashal, Jim Mahar, Tom Baldwin, Chikashi Sato, Kavita Sharma. U of I Collaborators: Karen Hume

Proposals Submitted

TITLE	LEAD PI	OTHER PERSONNEL	AWARD ADMIN UNIT	SPONSOR	PROJECT
					TOTAL
Conceptualizing A Non-intrusive Smart IoT Sensor for Continuous Health Monitoring with Reservoir Computing	Fouda, Mostafa		Electrical Engineering	Oak Ridge Associated University Inc - ORAU	\$5,000.00
Versatile Test Reactor (VTR) Instrumented Experiment	Imel, George		Nuclear Eng/Health Physics	Purdue University	\$52,769.00
Accelerating the Experimental Mission of VTR Through an Ex-Pile Operational Program	Pope, Chad		Nuclear Eng/Health Physics	Oregon State University - OSU	\$185,319.00
Informative Design of High Temperature Metal Hydride Moderators in Microreactors	LaBrier, Daniel		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	\$25,854.00
Plant generation risk modeling (Light Water Reactor Sustainability)	Pope, Chad		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	\$25,000.00
Synthesis, Characterization, and Testing of Catalysts	Rodriguez, Rene		Chemistry	Battelle Energy Alliance LLC - BEA - INL	\$9,649.00
Nuclear Operations AGN-201 reactor	Bowen, Vince	Ronneburg Debra (Investigator)	College of Technology	Idaho Career & Technical Education	\$27,000.00
NuScale SMR simulator	Bowen, Vince	Ronneburg Debra (Investigator)	College of Technology	Idaho Career & Technical Education	\$290,000.00
Innovative Helical Tube Heat Exchanger for Small Modular Reactors (SMRs) Technology: Computational Study and Experimental validation	Ali, Amir		Nuclear Eng/Health Physics	US Department of Energy - DoE	\$700,000.00
Investigating heat transfer in horizontal micro-HTGRs under normal and PCC conditions	Schultz, Richard		Nuclear Eng/Health Physics	Kansas State University	\$90,000.00
ESTEC Educational Support/Battelle 2021	Pitcher, Ryan		ESTEC	Battelle Energy Alliance LLC - BEA - INL	\$199,698.00
Real-Time Visualization of Structural Health Monitoring for Fission Battery/Micro-reactors	Mashal, Mustafa	Van Woerden Irene (Principal Investigator), Chrysler Andrew (Principal Investigator)	Civil/Environmntl Engineering	US Department of Energy - DoE	\$37,500.00
Real-time Simulation and Digital Twins	Pope, Chad		Nuclear Eng/Health Physics	Studsvik Scandpower, Inc	\$48,505.00
Evaluation of Ultra High-Performance Concrete for Nuclear Systems	Mashal, Mustafa	Ebrahimpour Arya (Principal Investigator), LaBrier Daniel (Principal Investigator)	Civil/Environmntl Engineering	Battelle Energy Alliance LLC - BEA - INL	\$300,000.00
Randomized Computing for Multiphysics Modeling and Simulations	Kerby, Leslie		COSE Informatics / Comp Sci	Battelle Energy Alliance LLC - BEA - INL	\$10,000.00
Nuclear Microreactor Heat Pipe Modeling and Simulation Database	Ali, Amir		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	\$17,935.00
2021 CAES Summer Visiting Faculty Program	Fouda, Mostafa		Electrical Engineering	Battelle Energy Alliance LLC - BEA - INL	\$17,182.00
2021 CAES Summer Visiting Faculty Program	Mashal, Mustafa	LaBrier Daniel (Principal Investigator)	Civil/Environmntl Engineering	Battelle Energy Alliance LLC - BEA - INL	\$17,182.00

Awards Received

AWARD TITLE	LEAD PI	OTHER PERSONNEL	AWARD ADMIN UNIT	SPONSOR	AWARD AMOUNT
A New Control Rod Drive Mechanism Design for ISU AGN-201M Reactor	Ali, Amir	Pope, Chad ; LaBrier, Daniel ; Combs, Ellen ; Scott, Jonathan ;	Nuclear Eng/Health Physics	US Department of Energy - DoE	TBD
Nuclear Microreactor Heat Pipe Modeling and Simulation Database	Ali, Amir		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	\$17,935.00
Nuclear Education Fellowship Program	Dunzik-Gougar, Mary Lou		Nuclear Eng/Health Physics	US Nuclear Regulatory Commission - NRC	\$398,050.00
Collaboration to Develop and Test a Remote, Canister-Monitoring System	LaBrier, Daniel	Rodriguez, Rene	Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	TBD
I-LOOP Material Compatibility Studies for Custom-Built Fittings	LaBrier, Daniel		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	TBD
Informative Design of High Temperature Metal Hydride Moderators in Microreactors	LaBrier, Daniel		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	TBD
FY21 INL Joint Appointment Agreement - Larry Leibrock	Leibrock, Larry		UBO - Science / Engineering	Battelle Energy Alliance LLC - BEA - INL	TBD
FY21 INL Joint Appointment Agreement- Chad Pope	Pope, Chad		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	TBD
Idaho State University Support of CAES Nuclear Safeguards and Security Certificate	Pope, Chad		Nuclear Eng/Health Physics	Battelle Energy Alliance LLC - BEA - INL	TBD
Real-time Simulation and Digital Twins	Pope, Chad		Nuclear Eng/Health Physics	Studsvik Scandpower, Inc	\$48,505.00
Synthesis, Characterization, and Testing of Catalysts	Rodriguez, Rene		Chemistry	Battelle Energy Alliance LLC - BEA - INL	\$9,649.00
New Materials and an Efficient Processing Approach for Materials for Harsh Environments - Advanced Fabrication and Joining of High-Performance Materials	Schoen, Marco		Mechanical Engineering	Battelle Energy Alliance LLC - BEA - INL	TBD